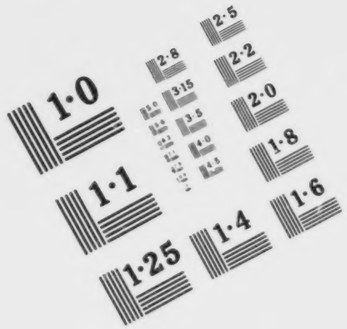

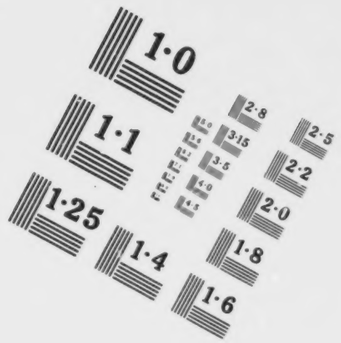

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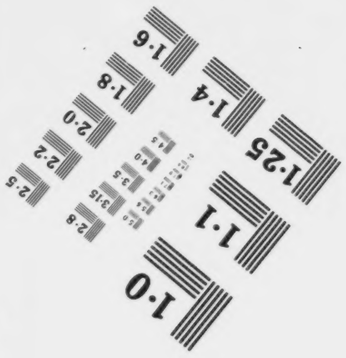
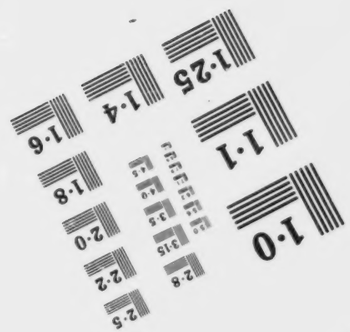




9-2350-311-20-1/990

ORGANIZATIONAL MAINTENANCE MANUAL FOR HULL, POWERPLANT, DRIVE CONTROLS, TRACKS, SUSPENSION AND ASSOCIATED HARDWARE

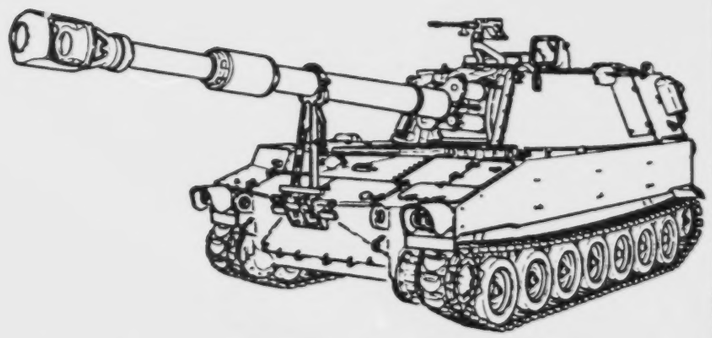
**HOWIZTER, MEDIUM, SELF-PROPELLED,
155MM M109A2
(2350-01-031-0586)**

AND

**HOWITZER, MEDIUM, SELF-PROPELLED,
115MM M109A3
(2350-01-031-8851)**

AND

**HOWITZER, MEDIUM, SELF-PROPELLED
155MM M109A4
(2350-01-277-5770)**



HEADQUARTERS, DEPARTMENT OF THE ARMY

NOVEMBER 1986

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This copy is a reprint which includes current pages from Change 1.

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WARNING
RADIOACTIVE MATERIALS

M140 alignment device and collimator are illuminated by sealed radioactive sources of tritium gas (H3). As long as these sources remain sealed, they do not emit any harmful radiation. There is no limit on handling time. Radioactively illuminated collimators are indicated by the radioactive sign shown above. If seal is broken, see below.

If there is no light present in the dark, or if the lens is broken, the local radiological protection officer (RPO) must be notified. The damaged collimator must be taken right away to a direct support maintenance unit. If you have touched any area which may be contaminated because of leakage or breakage, wash right away with soap and lukewarm water. The purging parts of sealed collimator must not be removed.

A. RULES AND REGULATIONS: Copies of the following Rules and Regulations are maintained at HQ AMCCOM, Rock Island, IL 61299. Copies may be requested, or information pertinent to these Rules and Regulations obtained, by contacting the AMCCOM (RPO) AUTOVON 793-6982, Commercial (309) 794-5843.

(1) 10CFR Part 19-Notices, Instructions and Report to Workers: Inspections.
(2) 10CFR Part 20-Standards for Protection Against Radiation.
(3) NCR License, License Conditions, and License Application

B. SAFETY PRECAUTIONS: The radioactive materials used in these instruments are tritium gas (H3) sealed in pyrex tubes. They pose no significant hazard to the repairman when intact. These sources illuminate the instrumentation for night operation. Tampering with or removal of the sources in field is prohibited by Federal law. In the event there is no illumination, notify the local radiological protection officer. Do not attempt to repair or replace the instrument in the field! If skin contact is made with any area contaminated with tritium, immediately wash with nonabrasive soap and water.

C. IDENTIFICATION: Radioactive self-luminous sources are identified by means of radioactive warning labels (as above, left). These labels should not be defaced or

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NO. 1

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 18 April 1989

TM 9-2350-311-20-1
ORGANIZATIONAL MAINTENANCE MANUALS FOR HULL, POWERPLANT, DRIVE CONTROLS TRACKS, SUSPENSION AND ASSOCIATED HARDWARE

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HOWITZER, MEDIUM, SELF-PROPELLED
155MM M109A4
(2350-01-277-5770)

TM 9-2350-311-20-1, 4 November 1986, is changed as follows:

1. The purpose of this change is to update this manual to the M109A4 configuration.
2. New or changed material is indicated by a bar in the margin of the page.
3. Remove the old page and insert the new page as indicated below.

REMOVE	INSERT	REMOVE	INSERT
i through ix	i through ix (x blank)	1-7 through 1-22	1-7 through 1-22
1-1 through 1-4	1-1 through (1-4.1 blank)/1-4.2	1-25 through 1-30	1-25 through 1-30

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D-69 and D-70	D-69 and D-70
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None	FP-7 (FP-8 blank)

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

WILLIAM J. MEEHAN II
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-37, Unit maintenance requirements for Howitzer, Medium, Self-Propelled, 155-MM, M109A2/A3.

removed and should be replaced immediately when necessary. Refer to local RPO or the AMCCOM RPO for instructions on handling, storage, or disposal.

D. STORAGE: All radioactively illuminated instruments which are defective will be evacuated to support maintenance. These items must be placed in a plastic bag and packaged in the shipping container from which the replacement was taken before evacuation to support maintenance. Space equipment must be stored in the shipping container, as received, until installed on the weapon. Storage of these items is recommended to be in an outdoor shed-type storage or unoccupied.

WARNING

CARBON MONOXIDE POISONING IS DEADLY

Carbon monoxide is a colorless, odorless, deadly poisonous gas, which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to carbon monoxide produces headache, dizziness, loss of muscular control, drowsiness, and coma. Permanent brain damage or death can result from severe exposure.

It occurs in the exhaust of fuel-burning heaters and internal-combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. The following precautions must be observed to insure the safety of personnel whenever the personnel heater, main, or auxiliary engine of any vehicle is operated for maintenance purposes or tactical use.

THE BEST DEFENSE AGAINST CARBON MONOXIDE POISONING IS ADEQUATE VENTILATION

1. DO NOT operate heater or engine of vehicle in an enclosed area unless it is ADEQUATELY VENTILATED.

2. DO NOT idle engine for long periods without maintaining adequate ventilation in personnel compartments.

3. DO NOT drive any vehicle with inspection plates, cover plates, or engine compartment doors removed unless necessary for maintenance purposes.

4. BE ALERT at all times during vehicle operation for exhaust odors and exposure symptoms. If either are present, IMMEDIATELY VENTILATE personnel compartments. If symptoms persist, remove affected personnel from vehicle and treat as follows: Expose to fresh air; keep warm; do not permit physical exercise; if necessary, administer artificial respiration. For detailed first aid instructions consult FM 21-11, First Aid for Soldiers.

WARNING SUMMARIES AND FIRST AID DATA PAGES

WARNING
NOISE HAZARD

Excessive noise levels are present any time the equipment is operating. Wear hearing protection while operating or working around equipment while it is running. Failure to do so could result in damage to your hearing. Seek medical aid should you suspect a hearing problem (ref. FM 21-11).

WARNING
FALLING EQUIPMENT HAZARD

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise extreme caution when working near a cable or under tension. In case of personnel injury, seek medical aid immediately (ref. FM 21-11).

WARNING
FIRE HAZARD

Diesel fuel and combustible materials are used in operation and maintenance of this equipment. Do not smoke or allow open flames or sparks in areas where diesel fuel and combustible materials are used or stored. DEATH or severe injury may result if personnel fail to observe this precaution. If you are burned, seek medical aid immediately (ref. FM 21-11).

WARNING
STEAM UNDER PRESSURE

Remove radiator cap slowly to relieve pressure before completely removing it when the engine is hot. Failure to follow this procedure could cause SEVERE INJURY. If you are scalded by steam, seek medical aid immediately (ref. FM 21-11).

WARNING
DO NOT USE MINERAL SPIRITS OR PAINT THINNER TO CLEAN THE HOWITZER.

Mineral spirits, paint thinners are highly-toxic and combustible. Prolonged breathing can cause dizziness, nausea, and even death (ref. FM 21-11).

DO NOT USE THESE MATERIALS

WARNING
DRY-CLEANING SOLVENT

Dry cleaning solvent (P-D-680) used to clean parts, is toxic flammable. Wear protective goggles and gloves and use only in a well ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. Do not smoke when using solvent. Failure to do so could cause SERIOUS INJURY. If you become dizzy while using cleaning solvent, get fresh air immediately, and if necessary, get medical attention. If contact with skin or clothes is made, flush thoroughly with water. If the solvent contacts your eyes, wash with water immediately, and obtain medical aid (ref. FM 21-11).

WARNING
FLAMMABLE

Battery gases can explode. Do not smoke, have an open flame, or create sparks around a battery, especially if the caps are off. SEVERE INJURY may result if you fail to heed this warning. Seek medical aid immediately should explosion occur (ref. FM 21-11).

WARNING
BURN HAZARD

Batteries contain sulfuric acid which can cause severe burns. Avoid contact with skin, eyes, or clothing, and remove all metal or jewelry. If battery electrolyte is spilled, stop its burning effects immediately (ref. FM 21-11).

WARNING
ELECTRICAL HAZARD

Be certain MASTER switch is OFF when working on hull electrical system to prevent injury due to electrical shock (ref. FM 21-11).

WARNING
NBC HAZARD

If Nuclear Biological Chemical (NBC) exposure is suspected, all air filter media must be handled by personnel wearing full NBC protective equipment (ref. FM 21-11).

WARNING
ROTATION HAZARD

Installed or removed, the rotation of the radiator cooling fans create a hazard during maintenance on a running engine. Exercise care to prevent injury, especially to fingers and hands, during maintenance operations on a running engine (ref. FM 21-11).

WARNING
FALLING EQUIPMENT/ROLLING VEHICLE HAZARD

Unless otherwise specified, perform all maintenance procedures with all equipment lowered to the ground, transmission in neutral, parking/emergency brake applied, and the engine stopped to prevent possible injury to personnel due to falling equipment or rolling vehicle (ref. FM 21-11).

WARNING
PARKING HAZARD

Do not park vehicles head to head. Personnel injury or damage to the vehicles could occur if one vehicle jumps (ref. FM 21-11).

WARNING
EXPLOSION HAZARD

Cylinders must not be dropped, struck, or subject to any temperature above +140°F (+60oC). This could result in an explosion and injury to personnel (ref. FM 21-11).

TECHNICAL MANUAL
No. 9-2350-311-20-1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *November 4, 1986*

ORGANIZATIONAL MAINTENANCE MANUAL FOR HULL, POWERPLANT, DRIVE CONTROLS, TRACKS, SUSPENSION AND ASSOCIATED COMPONENTS

HOWITZER, MEDIUM, SELF-PROPELLED:
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AND
HOWITZER, MEDIUM. SELF-PROPELLED
155MM, M109A4 (2350-01-277-5770)

REPORTING OF ERRORS
You can improve this manual by recommending improvements using DA Form 2028 (Recommended Changes to Publications and Blank Forms) or DA Form 2028-2 located in the back of this manual and mail the form direct to Commander, US Army Tank-Automotive Command, ATTN: AMSTA-MBC, Warren, MI 48397-5000. A reply will be furnished direct to you.

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HOW TO USE THIS MANUAL

This manual consists of:

1. Instructions for Organizational Maintenance (battery and battalion) on the M109A2, M109A3 and M109A4 155MM, Self-Propelled, Medium, Howitzer hull systems and components.
2. Location description and basic operation characteristics of the M109A2/M109A3/M109A4 hull systems and components.
3. Hull systems/components maintenance procedures to:
   a. Prepare the M109A2/M109A3/M109A4 for service upon receipt.
   b. Perform operational checks of systems/components.
   c. Perform preventive maintenance on systems/components.
   d. Perform troubleshooting of malfunctioning systems/components (isolation of malfunction causes).
   e. Removal, repair, and installation of hull system/components.
4. Appendixes for detailed listings of:

Appendix A.	References applicable to M109A2/M109A3/M109A4 vehicle, including supply manuals, forms, and other M109A2/M109A3/M109A4 publications.
Appendix B.	Maintenance policy, definition of terms. Maintenance Allocation Chart (MAC).
Appendix C.	Expendable supplies and material lists.
Appendix D.	STE-ICE Procedures - Instructions for use of specialized testing equipment on the howitzer engine.
Appendix E.	Engine Conversion - Detailed description/instructions of modification kit used for engine conversion on the howitzer.
Foldouts: (FO's)	Electrical schematics and diagrams (1 through 3).

Indexing:

Five major indexing procedures are used in this manual to help the technicians locate information rapidly.

1. Cover Index: Lists sections of text and page number. Includes Index Mark ( ) which lines up with Index Marks on the actual page of reference.

   Example:

   Troubleshooting. 3-1

2. Table of Contents - pages i through xi.

3. Chapter and section indexes listing data/information covered within the chapter and section.

4. Troubleshooting symptoms index identifies system malfunction and provides:

   (1) page references for specific troubleshooting procedures

   (2) identification of those problems/symptoms which are the responsibility of Direct Support Maintenance.

5. Index, pages I-1 through I-25. Alphabetical listing of Information.

Maintenance Text and Illustrations (Chapter 4 through 14)

1. Maintenance procedures are to be performed in the sequence shown in the text and illustrations. Step 1 must be performed before Step 2. Procedure A must be performed before Procedure B, and so on.

2. Equipment illustrations use numbers to identify parts of the system/components.

   Example:

   1. Remove both wiring harnesses (1) and (2).

   2. Remove four screws, four flatwashers, four lockwashers and four nuts (3).

CHAPTER 1
INTRODUCTION

GENERAL

The purpose of this chapter is to familiarize the technician with the M109A2/M109A3/M109A4 hull, powerplant, drive controls, tracks, suspension, and other hull-related components. The familiarization is provided through a physical description of major components the technician at organizational level is required to inspect, service, replace, or repair.

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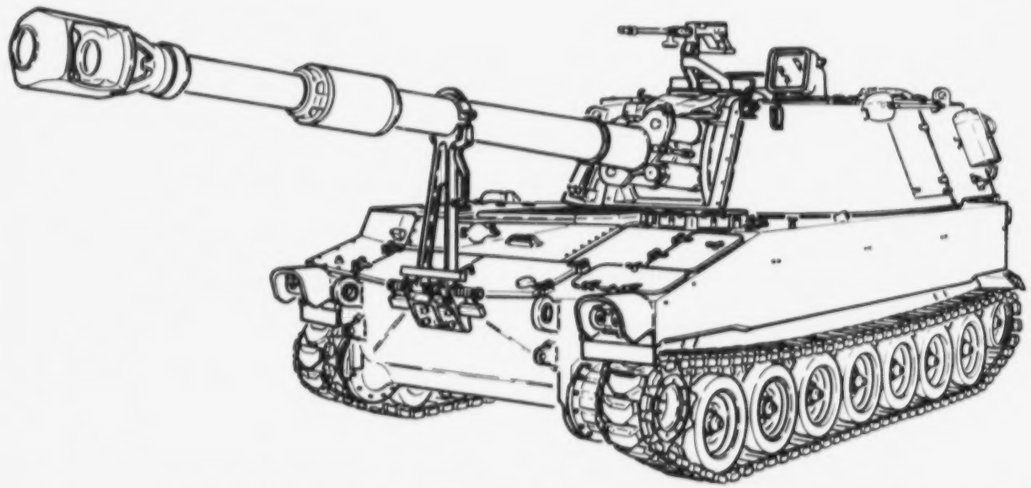

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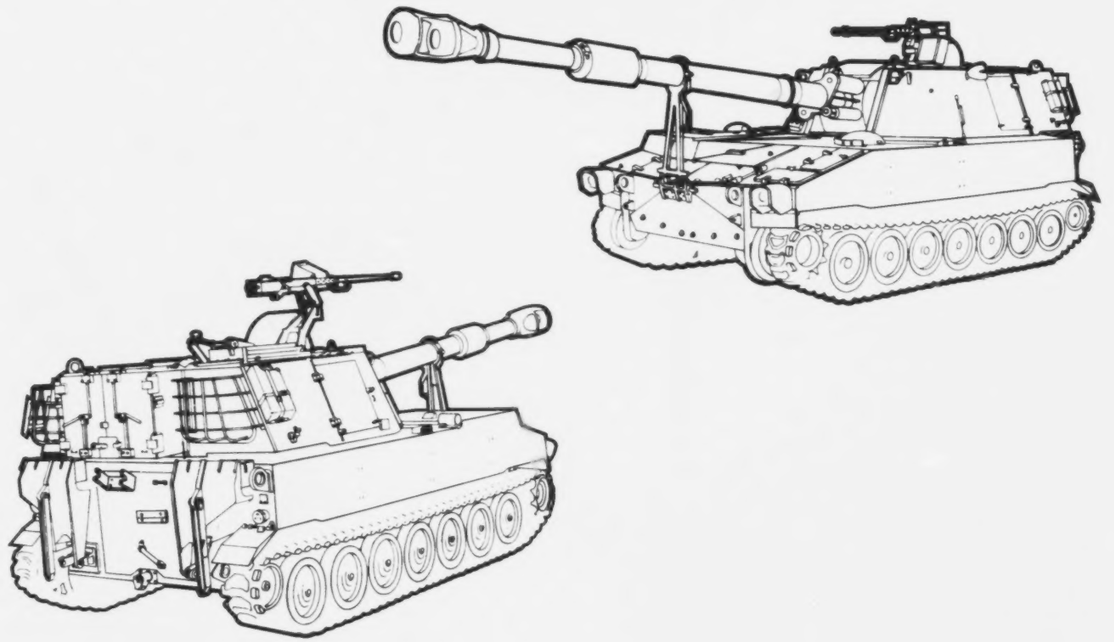

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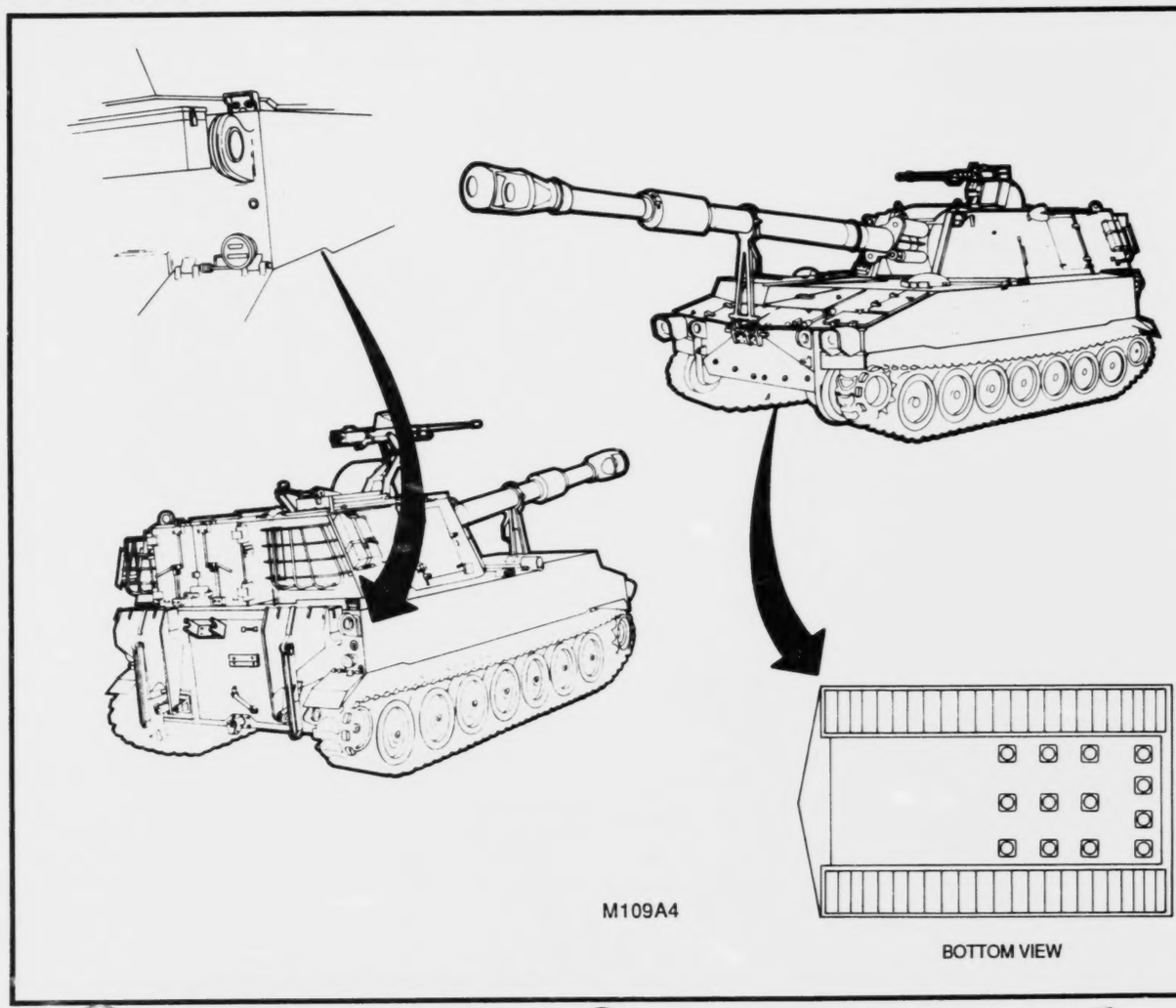


M109A4

BOTTOM VIEW

INTRODUCTION - SECTION I. GENERAL INFORMATION

1-1. SCOPE

This manual contains instructions for organizational level maintenance of the M109A2/M109A3/M109A4 hull, powerplant, drive controls, tracks, suspension, and other hull-related components.

Appendix A is a list of references, including supply manuals, forms, and other available publications applicable to the M109A2/M109A3/M109A4.

Appendix B contains maintenance policies, definitions of terms used, and the maintenance allocation chart, which spells out general maintenance responsibilities.

Appendix C contains a list of expendable supplies and materials you will need to operate and maintain the howitzer.

Appendix D contains STE/ICE procedures.

Appendix E contains modification procedures for the M109A3 engine compartment.

Schematic diagrams applicable to the hull are provided, inside back cover, on pages FO-1 through FO-4.

When the nature of the repair, modification, or adjustment is beyond the scope of facilities of Organizational Maintenance, the supporting unit should be informed so trained personnel with the correct tools and equipment may be provided, or other instructions issued.

Replacement or adjustment of parts or major assemblies that are normally support maintenance operations, may be done at organizational maintenace in an emergency if permission is obtained from the responsible commander. A replacement part or assembly, tool needed for work, and any special instructions should be obtained from the supporting maintenance unit.

1-2. MAINTENANCE FORMS, RECORDS AND REPORTS

Department of the Army forms and procedures used for equipment maintenance are listed in Appendix A. Refer to DA PAM 738-750, the Army Maintenance Management System, for instructions on use of the forms.

Accidents involving injury to personnel or damage to materiel will be reported on DA Form 285 (Accident Report) in accordance with AR 385-40.

Explosive ammunition malfunctions will be reported in accordance with AR 75-1.

1-3. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE

Destruction of the vehicle, armament, and equipment when subject to capture or abandonment in a combat zone, will be undertaken by the using army only when the unit commander decides such action is necessary in accordance with orders of, or policy established by, the Army commander.

Read TM 750-244-6 for information on destruction of all mechanical equipment. In general, destruction of essential parts, followed by burning, will usually be sufficient to render the vehicle, armament, and equipment useless. Time is usually critical.

Materiel must be damaged so that it cannot be restored to usable condition by either repair or cannibalization. If a lack of time or personnel prevents destruction of all parts, give priority to destruction of parts hardest to replace. It is important the same parts be destroyed on all units to prevent construction of one complete unit from several damaged ones.

All items of sighting and fire control instruments and equipment, especially telescopes, gunner's quadrants, and binoculars, are costly and difficult to replace. They should be conserved whenever possible. If you cannot carry them with you, destroy them by smashing with your sledge hammer, pick, or mattock. Throw the pieces in all directions.

When time is short, a method of destroying the equipment with materials at hand is as follows:

Retrieve or smash sighting and fire control equipment.

Load cannon with projectile and full powder charge. Attach a 50-foot (15.2-M) or longer lanyard to firing mechanism. Disconnect all recoil cylinders and fire the weapon.

INTRODUCTION - SECTION I. GENERAL INFORMATION - CONTINUED

1-3. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE - CONTINUED

Take a sledge hammer and bend the end of the recoil system rods.

A second method is to close the breechblock and toss several thermite grenades down the tube. Elevate the tube so that the grenades will fall against the breechblock. This will melt the breech and the powder chamber, causing them to fuse together.

1-4. PREPARATION FOR SHIPMENT AND STORAGE

Basic requirements for administrative storage are covered in TM 740-90-1 (Ref. Chapter 15, Section I).

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR's)

EIR's can and must be submitted by anyone who is aware of an unsatisfactory condition with the equipment design or use. It is not necessary to show a new design or use. It is not necessary to show a new design or list a better way to perform a procedure, just to simply tell why the design is unfavorable or why a procedure is difficult. EIR's will be submitted on Standard Form 368. Mail directly to Commander, US Army Tank-Automotive Command, ATTN: AMSTA-QRT, Warren, MI 48397-5000.

NOTE

When equipment failure occurs but is not caused by normal wear, poor operation, or accidental damage, an EIR must be submitted.

Table 1-1. AUTHORIZED EQUIPMENT CONFIGURATION CHANGES

CHANGE DOCUMENT	PART OR MODEL NO. TO BE MODIFIED	DESCRIPTION
M109A3 Engine Compartment Modification Kit, P/N 12268105 M109A2/M109A3/M109A4 SP Howitzer (Secure Lighting , P/N 570889)	M109A3 engine compartment M109A2/M109A3/M109A4 Self-Propelled Howitzer	Modify to accept engine P/N 122602210 (ref. app. E) Installs secure lighting to prevent detection on the modern battlefield.

INTRODUCTION - SECTION II. EQUIPMENT DESCRIPTION AND DATA

1-6. CAPABILITIES AND FEATURES

M109A2/M109A3/M109A4 electrical power is provided through a 24V generating system consisting of the following components: (Ref. Chapter 5).

- Four 12 volt batteries connected in series/parallel which provide 24V DC (nominal) to the master relay.
- 3 phase, 100 ampere alternator which maintains 24V electrical power through the voltage rectifier, voltage regulator, and to the master relay for systems operation. M109A4's have a 3 phase, 180 ampere alternator.
- Master relay delivers electrical power to electrically operated systems/equipment in the M109A2/M109A3/M109A4 vehicle (Hull and Cab) by turning on the master switch. Master switch, located on the driver's portable instrument panel, actuates the vehicle electrical system. With the powerplant off (engine not running), activation of the master switch provides delivery of electrical power direct through the alternator, voltage rectifier, voltage regulator, and master relay circuit.

POWERPLANT (engine and transmission)

The powerplant (engine and transmission) provides the mobility for the M109A2/M109A3/M109A4 vehicle. The powerplant consists of the following subsystems:

- Detroit Diesel 8V71T, model 96 or 99, diesel, liquid cooled V-8 engine, which generates 405 horsepower at 2350 rpm.
- Allison XTG-411-2A transmission with drive controls and final drive assemblies.

Drive control linkage to the transmission are steer control, shift control, and braking.

Final drive assemblies are the interface between the transmission and drive sprockets.

SUSPENSION

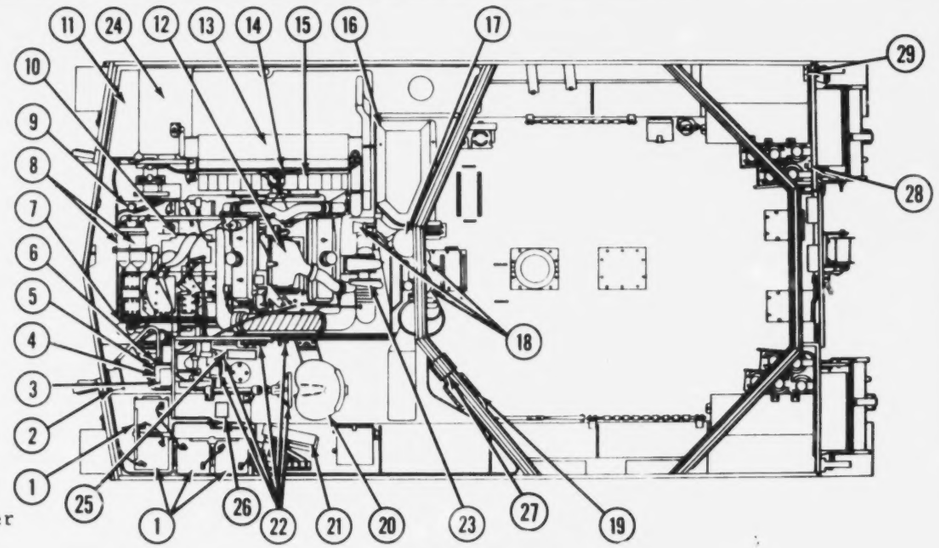
Independent torsion bar mounted, dual sized roadwheels (7 per side) which support and guide the vehicle track.

AIR CLEANER ASSEMBLY

Provides filtered air to the engine air intake system.

INTRODUCTION - SECTION II. EQUIPMENT DESCRIPTION AND DATA - CONTINUED

1-7. LOCATION OF MAJOR COMPONENTS



1. Batteries (4)
2. Rectifier
3. Master relay
4. Voltage regulator
5. Starter relay
6. Bilge pump relay
7. Secondary fuel filter
8. Oil filters (engine)
9. Primary fuel filter
10. Transmission
11. Coolant surge tank
12. Engine
13. Radiator
14. Alternator
15. Fan assembly
16. Air cleaner
17. Personnel heater
18. Fixed fire extinguisher
19. Accessory control box
20. Driver's seat
21. Fixed and portable instrument panels
22. Drive control
23. Turbocharger
24. Fuel tanks and pumps
25. Air purifier (M109A4)
26. Driver's heater (M109A4)
27. Cannoneer No.2 heater (M109A4)
28. Combat override switch (M109A4)
29. External power receptacle (M109A4)

NOT SHOWN: Bilge pump

NOTE

Primary fuel filter on some M109's is located inside the engine compartment access door.

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1-8. DIFFERENCES BETWEEN MODELS

Differences between models exist (1) when comparing the M109A2 and M109A3 vehicles; (2) when comparing one M109A3 to another M109A3 vehicle; (3) when comparing the M109A2/M109A3 and M109A4 vehicles.

HULL REAR DOORS
The hull rear doors differ among the vehicles. Earlier versions have double doors and later versions have single doors. All M109A2 vehicles have single doors (ref. p. 11-28).

PERSONNEL HEATER EXHAUST DEFLECTOR
On earlier vehicles the personnel heater exhaust deflector does not exist. All newer vehicles and all M109A2 vehicles have the personnel heater exhaust deflectors mounted on the exhaust grille.

NATO SLAVE RECEPTACLE
At present, not all of the M109 vehicles have NATO slave receptacles (ref. p. 8-68). Also the slave receptacle location differs between the M109A2/M109A3 and M109A4. The M109A2/M109A3 NATO Slave is located in the battery compartment. The M109A4 NATO slave is located in the drivers compartment.

PRIMARY FUEL FILTERS
The primary fuel filters are located in different areas of the engine compartment. Some older vehicle primary fuel filters are positioned near the engine vibration damper and the engine oil pan. The later vehicles primary fuel filters are positioned near the oil filters attached to the transmission (vehicle front)(ref. p. 6-14).

ENGINES
Engine differences between the M109A2 and M109A3 are as follows (M109A4's may have any of the following):

1. All M109A2 vehicles have engine P/N 12260210.
2. Most M109A3 vehicles will have either engine P/N 11665393 or P/N 11652632.
3. Some M109A3 vehicles may have the same engine as the M109A2 (P/N 11665393 & 11652632) to the newer engines (P/N 12260210) (ref. App. E for engine conversion instructions).

TRAVEL LOCKS
There are some travel lock differences involving the spring anchors. Differences are minor and shown on pages 11-35 and 11-36.

ROAD WHEEL AND IDLER WHEELS
Road wheel hubs and idler wheel hubs can be lubricated with oil or grease. Parts are different for either lubrication system. It is possible to find either oil or grease lubrication on either M109A3, M109A4 or M109A2 vehicles (ref. P. 10-14 and 10-28).

1-8. DIFFERENCES BETWEEN MODELS - CONTINUED

VENTILATED FACE PIECE SYSTEM (VFPS)
M109A4 vehicle hull's have a VFPS consisting at two air heaters, an air purifier and required hoses.

TELEPHONE TERMINALS
The location of vehicle telephone terminals differ on M109A2/M109A3 and M109A4 vehicles. The M109A2/M109A3 terminals are located on the hull rear bulkhead. M109A4 terminals are located on the hull rear roof (exterior).

EXTERNAL POWER RECEPTACLE
M109A4 vehicles have external power receptacles located on the rear hull bulkhead.

ENGINE COOLING FANS
M109A2/M109A3 and M109A4 vehicles may have different cooling fans installed. M109A4 and some M109A2/M109A3 vehicles have oil filled "improved fans". Other M109A2/M109A3 vehicles will have grease lubricated cooling fans.

ALTERNATOR AND CHARGING SYSTEM
M109A2/M109A3 vehicles have a 100 ampere alternator. M109A4 vehicles have a 180 ampere alternator. The location at both configurations is the same.

CREW COMPARTMENT SUBFLOOR DRAINS
M109A4 vehicles have 13 subfloor drains installed.

INTRODUCTION - SECTION II. EQUIPMENT DESCRIPTION AND DATA - CONTINUED

1-9. EQUIPMENT DATA

GENERAL		METRIC EQUIVALENT
Crew	6	
Weight (combat loaded)	55,000 lbs	24848 kg
Weight (less crew, fuel, and stowage)	46,539 lbs	21110 kg
Length (with armament)	359.375 inches	9.12 M
Length (without armament)	243.75 inches	6.19 M
Width	124 inches	3.1 M
Height	120.43 inches	3 M
Lowest operable height	109.93 inches	2.8 M
Ground clearance	18 inches	46.0 Cm
Shipping volume	2250 cu. ft.	63.7 Cu M
Bridge classification	26	25000 Kg
PERFORMANCE		
High speed (max)	35 mph (governed)	56.3 Kmph
Low speed (max)	6 mph	9.6 Kmph
Reverse speed (max)	7 mph	9.6 Kmph
Maximum grade	60%	
Maximum trench	72 inches	1.83 M
Maximum vertical wall	21 inches	0.53 M
Turn radius (min)	1 vehicle length	
Cruising range	217 miles	349 Km
Fuel capacity	135 gallons	511 L

ENGINE

Type/model	Detroit Diesel 8V71T, model 96 or 99, liquid cooled	
Manufacturer	Detroit Diesel, Allison Div., GMC	
Horsepower (gross)	405 at 2350 RPM	
Horsepower (net)	345 at 2300 RPM	
Displacement	567.4 cu. in.	9300 cc
Bore	4.25 inches	10.8 CM
Stroke	5 inches	12.7 Cm
Compression ratio	17:1	
Torque (max gross)	980 lb-ft at 1700	1323 Nm
Torque (max net)	895 lb-ft at 1600	1208.3 Nm
Ignition	Compression	
Fuel oil	Diesel: 40 cetane, VV-F-800	
Regular grade (DF-2) (NATO F-54)	Temperature Range: +20° to 115°F (-7° to 46°C)	
Winter grade (DF-1)	Temperature Range: -20° to +20°F (-29° to 7°C)	
Arctic grade (DF-A)	Temperature Range: -65° to -25°F (-54° to 32°C)	

NOTE

Under emergency conditions and in military operations involving jet transportation, JP-5 aircraft turbine engine fuel may be used instead of VV-F-80.

Fuel acceptance (safe max)	50 GPM	3.1 L/sec
Lubrication oil system capacity (refill)	28 quarts (approx)	26.5 L
Lubrication oil system capacity (dry)	38 quarts (approx)	36 L
Cooling system capacity (refill)	14 gallons	53 L
Cooling system capacity (dry)	22 gallons	83 L

INTRODUCTION - SECTION II. EQUIPMENT DESCRIPTION AND DATA - CONTINUED

1-9. EQUIPMENT DATA - CONTINUED

TRANSMISSION		METRIC EQUIVALENT
Model	XTG-411-2A	
Manufacturer	Allison Div., GMC	
Usable ranges:		
First (low range)	5.69:1	
Second (low intermediate)	3.17:1	
Third (low intermdiate)	1.58:1	
Fourth (high range)	0.79:1	
Low reverse (R-1)	5.60:1	
High reverse (R-1)	3.79:1	
Steer	1.475:1	
Steer control - first and second	Clutch brake	
Steer control - third and fourth	Geared	
Brakes	Mechanical - applied	
Oil capacity (refill)	14 gallons	53 L
Oil capacity (dry)	21 gallons	79.5 L

ELECTRICAL SYSTEM	
Voltage (nominal)	24
Batteries (12 volts each, series - parallel connected)	4
Type	6 TN
Alternator (M109A2/M109A3)	
Manufacturer	Leece-Neville
Model	A001-5504AA
Type	3 phase
Amperage	100
Alternator (M109A4)	
Manufacturer	Leece-Neville
Model	A001-5520AB
Type	3 phase
Amperage	180

Intercommunication set (model)	AN/VIC-1	
Outlets	5	
External extension (model)	C-988/U	

SUSPENSION

Type	Independent torsion bar	
Roadwheel	14 sets	
Size	24 inches	0.6M
Loadings		
1, 2, and 7 positions	4000 lbs (approx)	1814 Kg
Intermediate positions	2600 lbs (approx)	1179 Kg

TRACK

Adjustment at idler wheel	Track adjuster	
Shoes per track	79	
Pitch	6 inches	15.2 Cm
Width	15 inches	38 Cm

FINAL DRIVES AND SPROCKETS

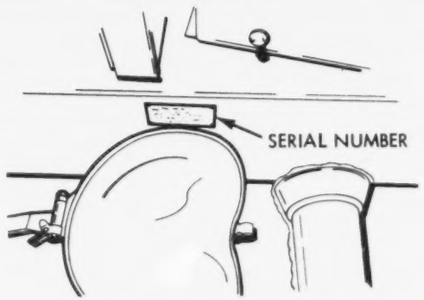
Type	Spur gear	
Ratio	4.36:1	
Sprocket pitch diameter	19.5 inches	49.5 Cm
Number teeth per sprocket	10	

FIRE EXTINGUISHER

Fixed - 10-pound bottles	2
Portable - 5-pound bottles	1

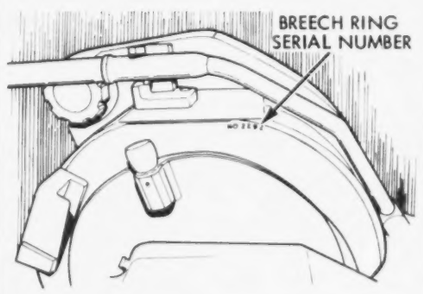
INTRODUCTION - SECTION II. EQUIPMENT DESCRIPTION AND DATA - CONTINUED

SERIAL NUMBER LOCATIONS

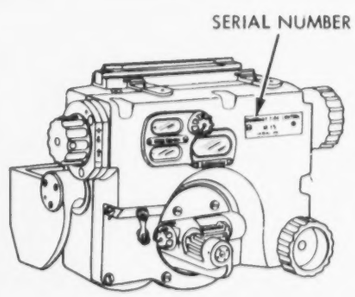


VEHICLE-On vehicle data plate left of driver's seat

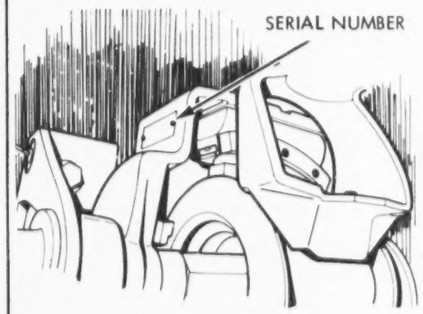
HOWITZER, MEDIUM, SELF-PROPELLED: 155MM, M109A2/M109A3
CREW 6 MEN
U.S. ARMY SERIAL NO._____
M'FD BY:
OPERATOR'S MANUAL: TM9-2350-311-10
MAINT. MANUALS: LO9-2350-311-12, TM9-2350-311-20,-1,
-20-1,-20P-1,-20P-2,34-1,34-2,34P-1,34P-2
MAX. VEHICLE SPEEDS
LOW: 6MPH HIGH: 35MPH REVERSE: 7MPH
OVERALL LENGTH: 359-3/8 in. LOWEST OPERABLE HEIGHT: 114
OVERALL WIDTH: 124 in. SHIPPING VOLUME 2573 FT^3
OVERALL HEIGHT: 129-1/8 in. FIGHTING WEIGHT: 27.5 TONS
_____NATIONAL STOCK NO.: 2350-01-031-0586 (A2)
_____2350-01-031-8851 (A3)



BREECH-On rear of breech ring.

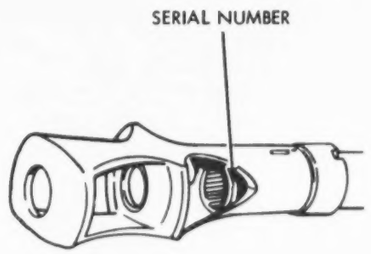


M15 QUADRANT-Upper right-hand corner



M145 MOUNT-Upper left side.

TA471970



TUBE-On tip of tube.

M109A3 ONLY

ALIGNMENT DEVICE M140-
On vertical tube.

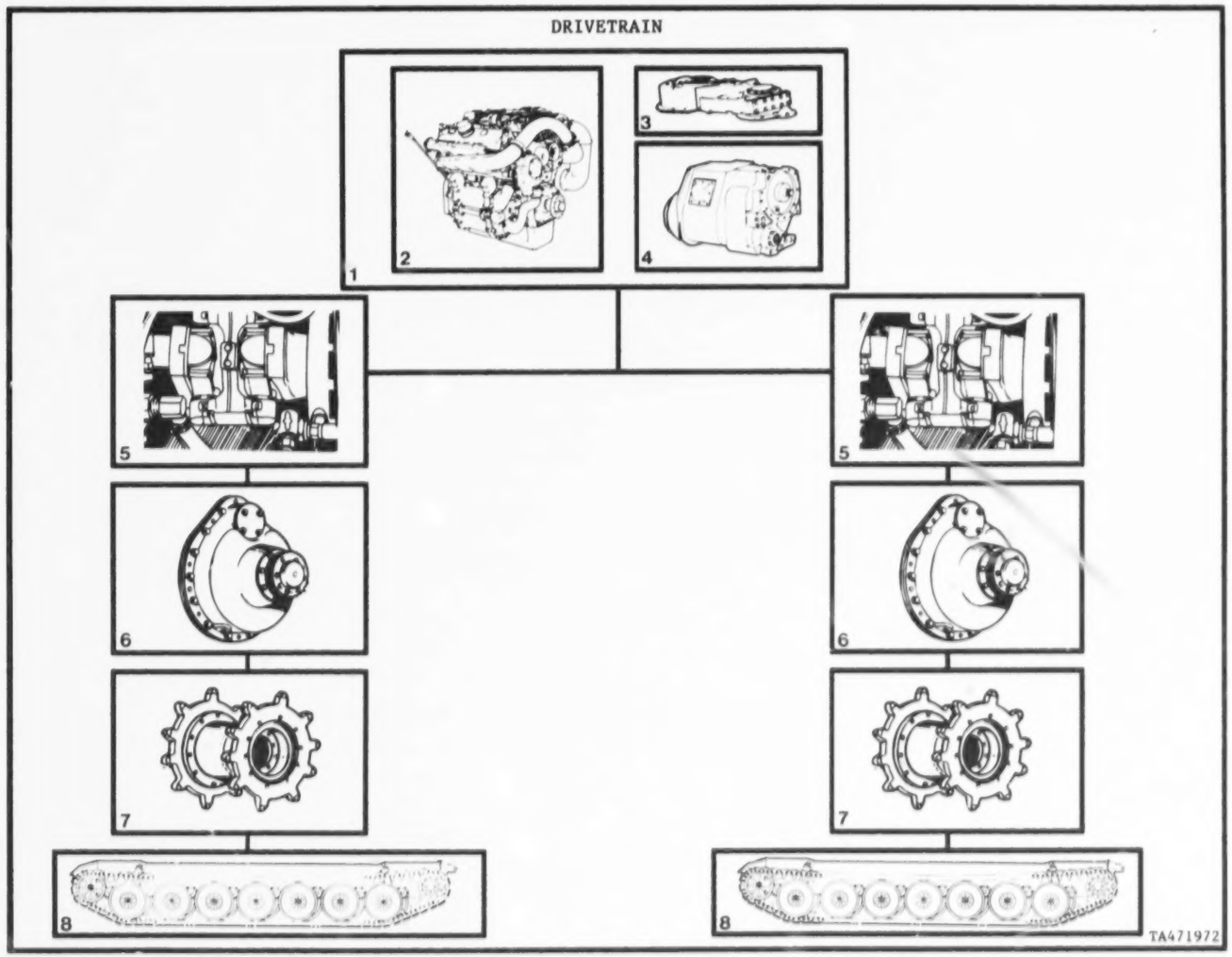
INTRODUCTION - SECTION III. PRINCIPLES OF OPERATIONS

1-10. EQUIPMENT OPERATION AND DESCRIPTION

The purpose of this section is to familiarize the technician with the basic operating characteristics of the M109A2/M109A3/M109A4 hull-related systems and components. A basic physical description of the systems/components and an operational flow diagram is provided. Use the following general index to pinpoint a particular system:

	PAGE
DRIVETRAIN	1-20
FUEL SYSTEM	1-22
COOLING SYSTEM	1-24
ELECTRICAL SYSTEM	1-26
INSTRUMENT PANELS	1-28
DRIVE CONTROLS	1-30
SUSPENSION SYSTEM	1-32

TA471971


DRIVETRAIN
1
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8
TA471972

DRIVETRAIN

The drivetrain flow diagram illustrates the transfer of power generated by the powerplant to the tracks.

A Powerplant (1) - consists of engine (2), transfer assembly (3) and transmission (4) which can be removed from the vehicle as a complete unit. The powerplant may be operated removed from the vehicle with a minimum of special equipment (ref. Chapter 4).

B Engine (2) - is a Detroit Allison, liquid cooled 2-stroke cycle, diesel-type Model 8V71T, equipped with exhaust-driven turbocharger. The engine develops 405 horsepower at 2350 RPM and delivers power to the transfer assembly (3).

C Transfer assembly (3) - receives power from the engine (2) and transfers that power to the transmission (4).

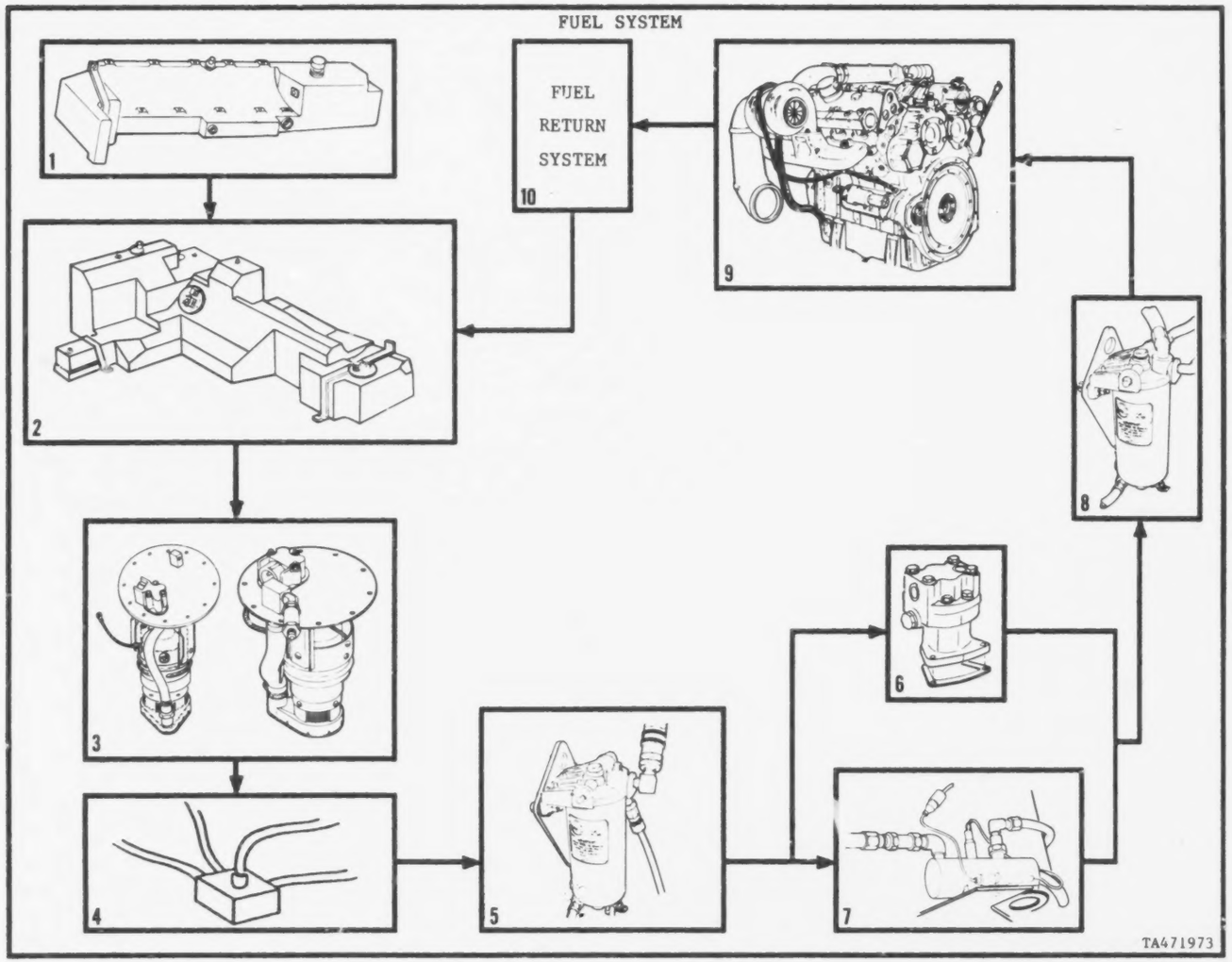
D Transmission (4) - oil cooled and mechanically and hydraulically operated. It receives power from the engine through a geared power transfer assembly (3). The transmission has 7 gears - 4 forward, 1 neutral, and 2 reverse gears - and delivers power to the left and right drive sprockets through the output shaft, universal joints (5) and final drive assemblies (6). It also functions as the steering and braking mechanism for the M109A2/M109A3/M109A4.

E Universal joints (5) - receives the transmission power output and transfers the output to the final drives (6).

F Final drives (6) - reduces the power output it receives from the universal joints through a series of gear reductions.

G Sprockets and hubs (7) - bolted to the final drive, the sprocket and hub transfers the power output received from the final drives and distributes it to the track (5).

H Track (8) - the rotation of the track provides mobility to M109A2/M109A3/M109A4 vehicles. The track consists of track shoes connected together by end connectors. Each track shoe has a centerguide that runs through the roadwheel and idler wheel to keep from "throwing" a full track.


FUEL SYSTEM
1
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9
10
FUEL
RETURN
SYSTEM
TA471973

FUEL SYSTEM

The fuel system flow diagram shows the interaction between the electrical system and fuel system to determine the flow of fuel.

A Upper fuel tank (1) - provides additional fuel to the lower fuel tank (2). Filling of both fuel tanks take place through the filler neck of the upper fuel tank.

B Lower fuel tank (2) - provides for fuel storage and for the return of unused fuel of the fuel return system (10).

C Electric fuel pumps (3) - activated by the MASTER switch on the instrument panel (M109A2/M109A3) or by an oil pressure switch (M109A4), these pumps distribute fuel from the lower fuel tank (2) to the fuel distribution center (4).

D Fuel distribution center (4) - distributes fuel to primary fuel filter (5).

E Primary fuel filter (5) - first filter from fuel tank.

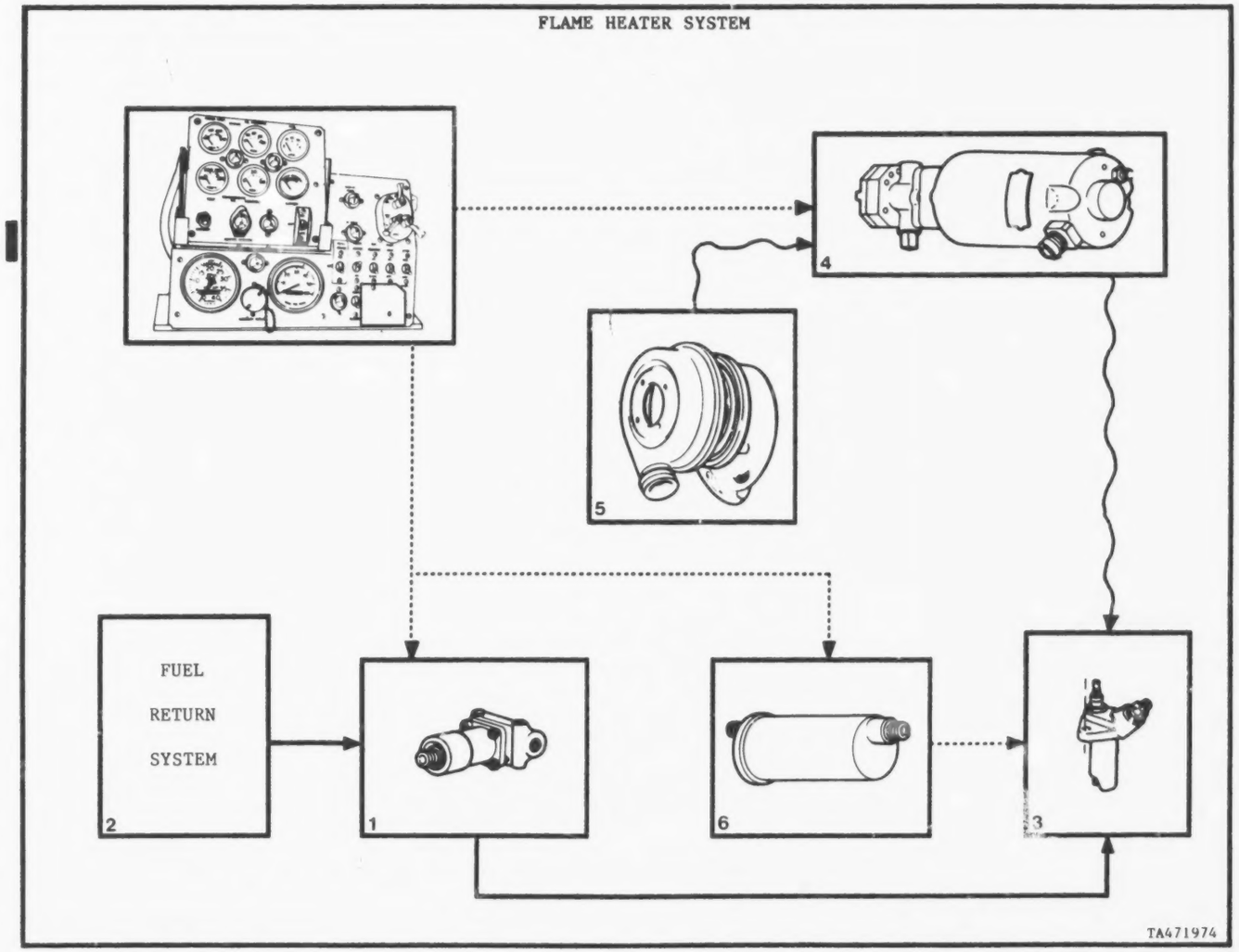
F Engine driven fuel pump (6) - when engine is operating, pumps fuel from the primary fuel filter (5) on to the secondary fuel filter (8).

G Electrically driven fuel pump (7) - when engine is not operating, the electrically driven fuel, activated by the fuel prime switch on the instrument panel, pumps fuel from the primary filter (5) to the secondary filter (8).

H Secondary fuel filter (8) - filters fuel a second time for additional impurities.

I Engine (9) - burns fuel.

J Fuel return system (10) - distributes excess fuel either back to the lower fuel tank (2) or flame heater system.

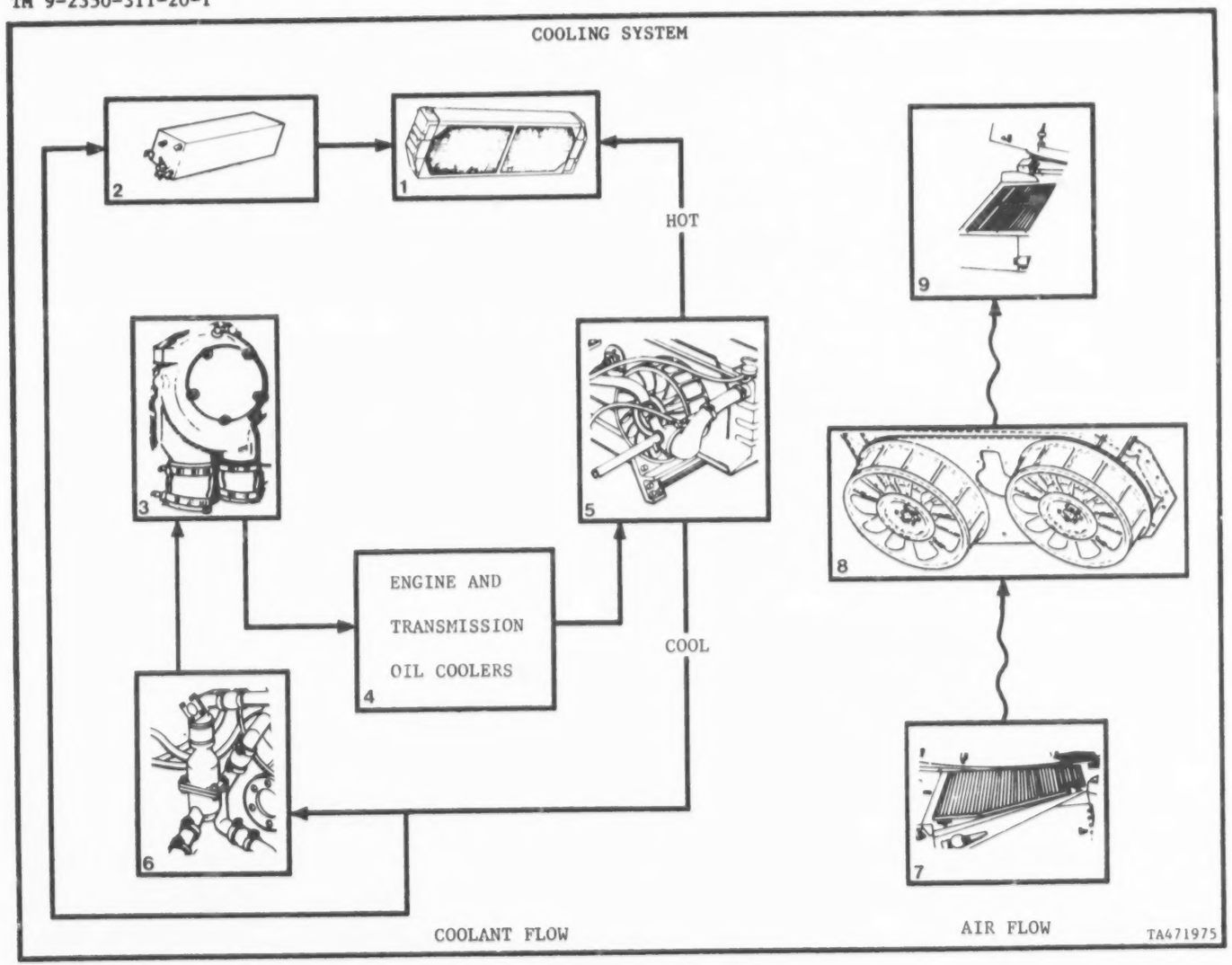

FLAME HEATER SYSTEM
4
5
FUEL
RETURN
SYSTEM
2
1
6
3
TA471974

FLAME HEATER SYSTEM

A Flame heater solenoid valve (1) - receives fuel from fuel return system (2) and delivers this fuel to flame heater box (3).

B Air motor and pump (4) - pulls air from turbocharger (5) and pumps it to the flame heater box (3).

C Flame heater igniter (6) - provides electrical ignition of atomized fuel in flame heater box (3).


COOLING SYSTEM
2
1
HOT
9
3
5
ENGINE AND
TRANSMISSION
OIL COOLERS
4
8
COOL
6
7
COOLANT FLOW
AIR FLOW
TA471975

COOLING SYSTEM

A Radiator (1) - cools the coolant flowing through it.

B Surge tank (2) - allows for overflow from the radiator (1) in this closed cooling system. The capacity of the surge tank and the radiator (1) is 22 gallons.

C Engine driven coolant pump (3) - pulls coolant from the radiator (1) and distributes it to the transmission and engine oil coolers (4) and back to the radiator (1) or surge tank (2).

D Engine and Transmission Oil Coolers (4) - cools the oil within the engine and transmission by surrounding the oil coolers with coolant.

E Inlet thermostat (5) - directs the flow of the coolant from the engine to different areas of the cooling system. If the engine is running hot enough to open the inlet thermostat, the coolant flow will be directed to the radiator (1) so it can be cooled. If the engine is running cool enough, the inlet thermostat will direct flow (1) to the bypass thermostat (6) or surge tank (2).

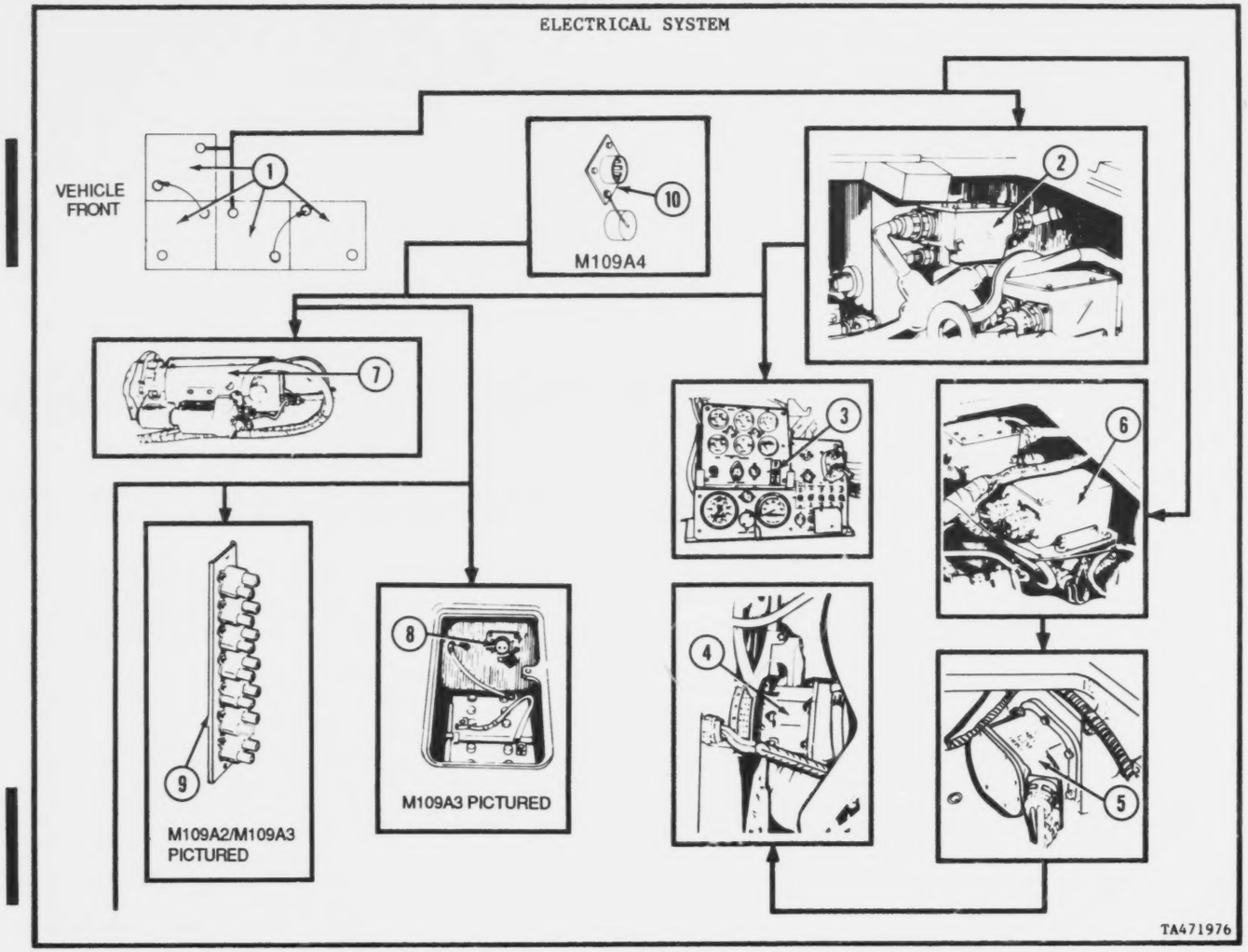
F Bypass thermostat (6) - allows inflow from the inlet thermostat (5) and cooling crossover tube and directs it back to the engine driven coolant pump (3) and to the oil coolers (4).

G Air intake grille (7) - allows air to be pulled into the engine compartment by the radiator fans (8).

H Radiator fan assembly (8) - pulls in air through the air intake grille (7), across the engine and pushes the air through the radiator (1) "honeycomb". The air is then discharged through the exhaust grille (9).

I Exhaust grille (9) - allows air pushed and pulled by the fan assembly (8) through the radiator (1) and back out of the engine compartment.

ELECTRICAL SYSTEM



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ELECTRICAL SYSTEM

The M109A2/M109A3/M109A4 electrical system consists of:

A Batteries (1) - four 12 volt connected in series and parallel to deliver 24V DC (nominal) to the master relay (2).

B Master relay (2) - delivers electrical power (24V DC) to operating systems when the master switch (3) is on. Delivers power directly to the:
Slip ring contact board (ref. TM 9-2350-311-20-2)
Engine starter (7)
Slave receptacle (8) M109A3
Circuit breaker board (9)
Cab (slip ring segment board) (ref. TM 9-2350-311-20-2)

C Master switch (3) - when activated draws 24V DC from the battery through the master relay (2), to operate the M109A2/M109A3/M109A4 electrical systems. With the master switch ON, systems can be operated without running the engine.

D Alternator (4) - engine driven and delivers 24V DC (nominal) to the rectifier (5).

E Rectifier (5) - full wave bridge rectifier converts the generator AC voltage to DC voltage which is in turn delivered to the voltage regulator (6).

F Voltage regulator (6) - controls the delivery of 24V DC to the vehicle operating systems through the master relay (2) and also acts as a recharger for the batteries when the engine is operating.

G External power receptacle (10) provides vehicle auxiliary power from an external source.

INSTRUMENT PANELS

The M109A2/M109A3/M109A4 has two instrument panels. The Portable Instrument Panel (1) consists of the following:

A Master switch (3) - activates the vehicle electrical system.

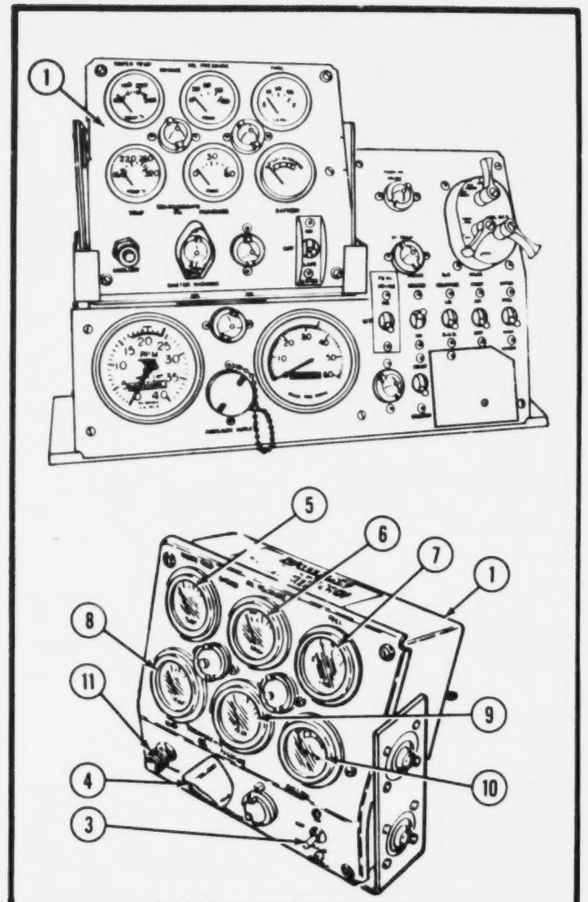
B Master Warning Light (4) - gives indication of critical engine operating conditions for:

Transmission oil low pressure
Transmission oil high temperature
Engine coolant high temperature
Engine oil low temperature

C Gages which indicate:

Water temperature (5)
Engine oil pressure (6)
Fuel level (7)
Transmission oil temperature (8)
Transmission oil pressure (9)
Battery condition (10)

D Low Coolant Warning Indicator Lamp (11)



PORTABLE INSTRUMENT PANEL

TA471977

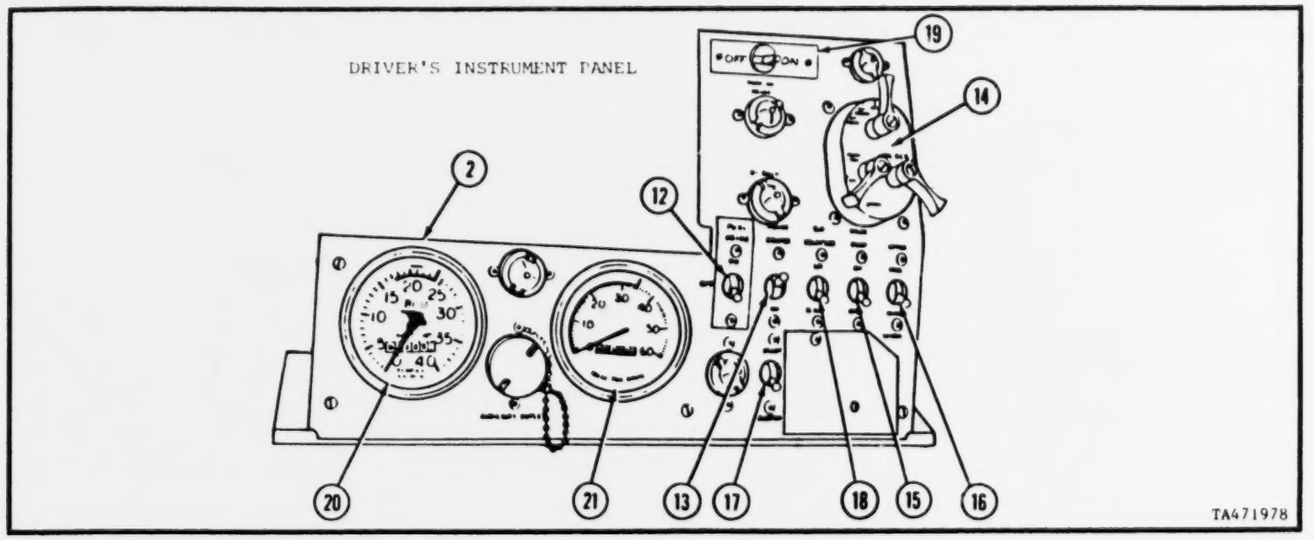
The driver's instrument panel (2) contains:

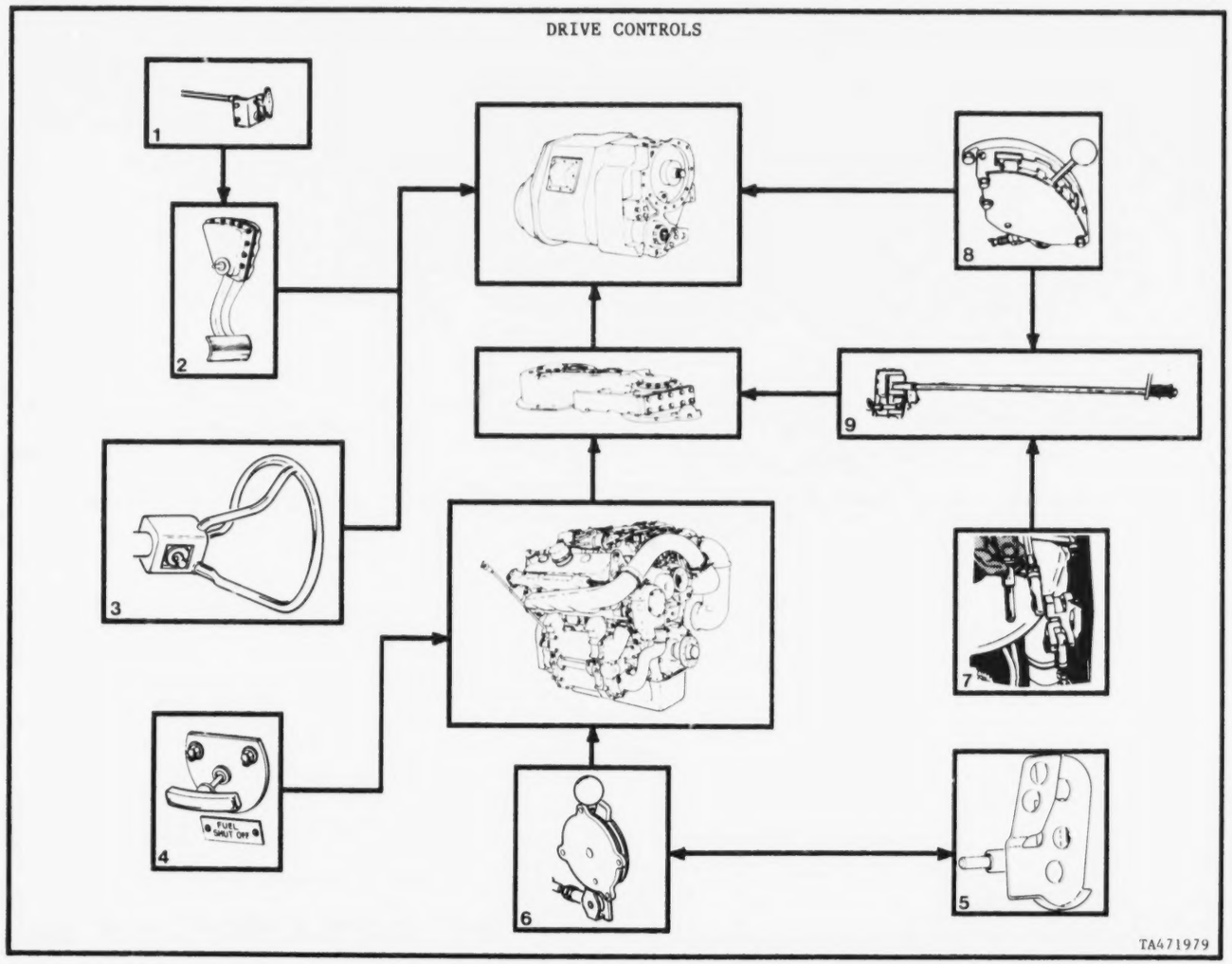
E Control switches which activate:

- Fuel prime pump (12)
- Flame heater (13)
- Driving lights (14)
- Bilge pump (15)
- Fuel gage transmitters (16)
- Starter motor (17)
- Infra Red/Black Out light switch (18)
- NBC Power Switch (M109A4 only) (19)

F Gages which indicate:

- Engine RPM - tachometer (20)
- Vehicle speed - speedometer (21)




DRIVE CONTROLS
1
2
3
4
FUEL SHUT OFF
5
6
7
8
9
TA471979

DRIVE CONTROLS

A Parking brake (1) - when set moves brake apply to provide internal braking for right and left transmission drive assemblies.

B Brake pedal (2) - when depressed provides internal braking for right and left transmission drive assemblies.

C Steering (3) - applies brakes to track on the inside of the turn. Left turn - brake is applied to left drive output. Right turn - brake is applied to right drive output.

D Fuel shut-off (4) - when the fuel shut-off handle (4) has been pulled out, it cuts the fuel supply and shuts down the engine.

E Accelerator Pedal (5) - when depressed accelerates the engine, so engine operates with greater RPMs. When accelerator pedal is released, engine rpms will return to idle speed.

F Hand throttle control (6) - is another method of controlling the speed of (rpms) of the engine. (Push forward - engine speed increases. Pull back - engine speed decreases).

G Engine throttle control rod (7) - is the throttle linkage from the hand throttle control (6) and the accelerator pedal (5).

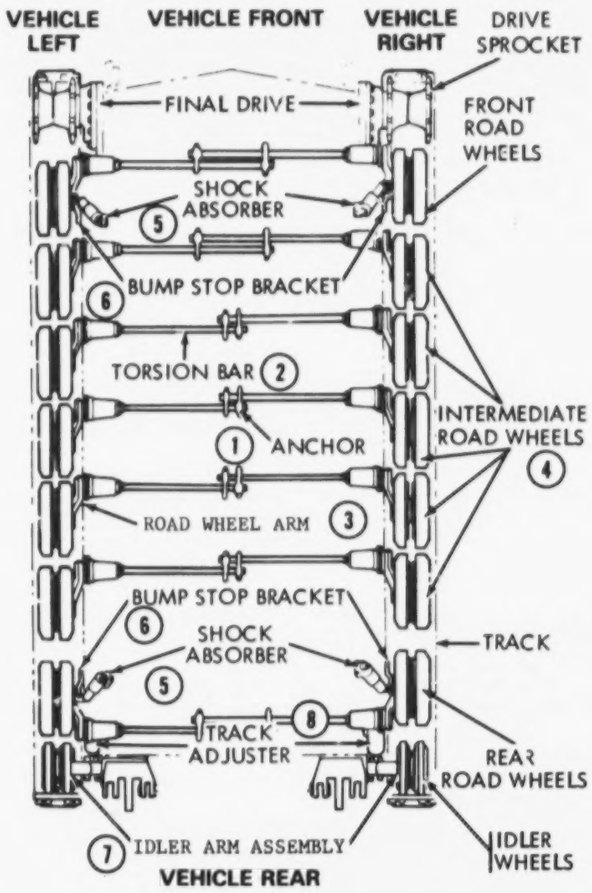
H Shift control (8) - shift control selects the speed range and the direction of the power output of the transmission.

NOTE

The transmission throttle valve control rod (9) does not govern the speed of the vehicle or the transmission RPM. Speed and RPM are determined by engine RPM and the shift control (8) position.

I Transmission throttle valve control rod (9) - is interconnected with engine throttle control rod (7) and transmision shift control (8). With the engine operating and the shift control in the neutral position, the transmission throttle valve is Locked Out. When the shift control (8) is in one of the drive gears (or reverse), the transmission throttle valve is Locked In allowing transfer of power from the transfer assembly into the transmission and to the drive assembly.

SUSPENSION SYSTEM



TA471980

SUSPENSION SYSTEM

A Torsion bar anchors (1) - secures the ends of the torsion bars (2). One anchor secures two torsion bars, one from the right and one from the left.

B Torsion bars (2) - secured at the anchor (1) and connected to the roadwheel arm (3), the torsion bar acts like a spring for the roadwheel and track.

C Roadwheel arm (3) - connected to the torsion bar (2), the roadwheel arm provides a pivot point between the torsion bar (2) and the roadwheel (4).

D Roadwheels (4) - are suspended from the hull of the howitzer by roadwheel arms (3). There are seven roadwheels per side located between the sprocket and idler wheel. The roadwheels have two wheel halves separated by a valley to allow track centerguides to pass between the halves.

E Shock absorbers (5) - handle differences in the terrain in which the vehicle operates. They are located in the front and back of the vehicle (roadwheels 1 and 7).

F Bump stops (6) keep shock absorbers (5) from moving beyond their limits.

G Idler arm assembly (7) and track adjuster (8) - the idler arm assembly consists of an idler arm with an idler wheel attached, all rotating within the idler arm housing. The angle of the idler arm and wheel is determined by the length of track adjuster. Increase or decrease track tension by adding or removing GAA grease to/from the track adjuster.

INTRODUCTION - SECTION IV. PAINTING AND RESTENCILING MARKING

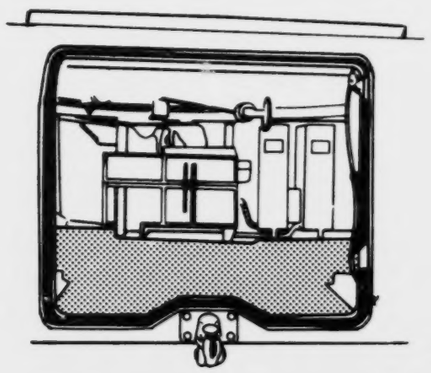
1-11. PAINTING INSTRUCTIONS

Use the following publications for painting. A. TM 43-0139: Preparation of the materiel for painting, methods of painting, and materials to be used; B. TB 43-0209: Instructions on color and marking of military vehicles; C. FM 5-20: Instructions for camouflage painting.

NONSKID AREAS

Deck covering compound MIL-D-23003, Type 2, will be used to coat areas where personnel walk, such as front deck plates and crew compartment interiors. This material is resistant to oils and hydraulic fluids. Areas to be coated are shown below.

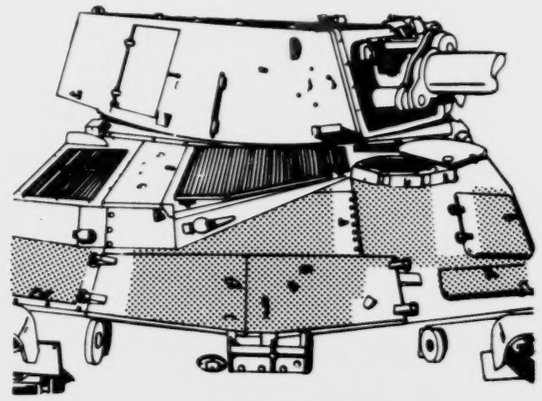
CREW COMPARTMENT



NOTE

CREW COMPARTMENT FLOOR WILL BE COATED WITH FLIGHT DECK COMPOUND MIL-D-23003, TYPE 2.

HULL FRONT ACCESS DOORS AND GRILLES

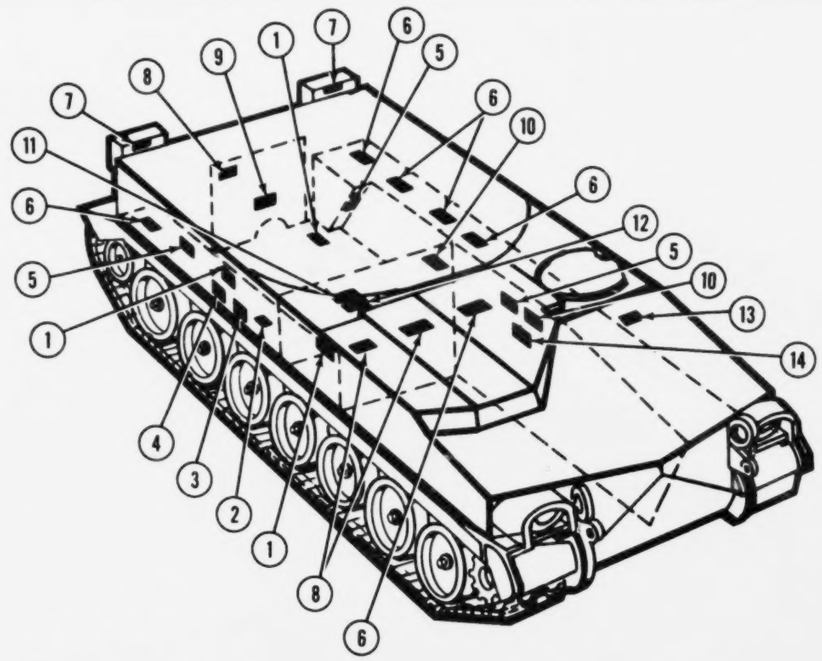


NOTE

SHADED AREAS WILL BE COATED WITH FLIGHT DECK COMPOUND MIL-D-23003, TYPE 2.

TA471981

1-12. STENCIL LOCATIONS FOR BASIC ISSUE ITEMS



LEGEND

1. Projectile stowage
2. CLGP (or powder can stowage)
3. Projectile spacer
4. Portable fire extinguisher
5. Canteen
6. Powder cans
7. Rations (exterior)
8. Fuses
9. Telephone
10. Rifles
11. Bucket
12. M14 aiming light
13. Spare periscope (M45)
14. Flashlight

TA471982

CHAPTER 2
GENERAL HULL MAINTENANCE

GENERAL

This chapter presents instructions and information needed to keep the M109A2/M109A3/M109A4 hull equipment and components in good repair. These instructions provide a step-by-step, and item-by-item, illustrated text describing M109A2/M109A3/M109A4 equipment, component service and maintenance.

The maintenance functions described in this chapter are limited to those functions authorized by the MAC for Organizational Maintenance level activities. If maintenance is needed on any hull equipment or components that are not discussed in this chapter, notify Direct Support Maintenance for assistance.

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SECTION I. REPAIR PARTS, SPECIAL TOOLS, TMDE AND SUPPORT EQUIPMENT

2-1 GENERAL 2-2
2-2 COMMON TOOLS AND EQUIPMENT 2-2
2-3 SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT 2-2
2-4 REPAIR PARTS 2-2

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2-6 INITIAL PROCEDURES 2-3
2-7 PREOPERATIONAL PROCEDURES 2-6
2-8 OPERATIONAL PROCEDURES 2-8
2-9 EQUIPMENT FAULTS AND REPORTS 2-9

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GENERAL HULL MAINTENANCE - SECTION I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

2-1. GENERAL

Tools, equipment, and repair parts will be issued to Organizational Maintenance personnel for maintenance. The tools and equipment issued should only be used for tasks in this manual. When not in use, these tools should be properly stored in the tool chests and/or rolls provided.

2-2. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organizational and Equipment (MTOE) applicable to your unit.

2-3. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

Certain tools and equipment, especially designed for Organizational maintenance, repair, and general use are listed in Appendix B for information only. This list is not to be used for requisitioning parts.

2-4. REPAIR PARTS

Repair parts are listed and illustrated in the repair parts and special tools list covering Organizational Maintenance (TM 9-2350-311-24P-1).

Gaskets, packings, preformed packings, seals, lockwashers, locknuts, self-locking nuts, cotter pins and spring pins must be replaced. Bushings must be replaced only if removed.

Springs must be replaced if broken, kinked, cracked, or do not conform to standards specified in the repair data.

GENERAL HULL MAINTENANCE - SECTION II. SERVICE UPON RECEIPT

2-5. GENERAL INFORMATION

This section covers the procedures for servicing M109A2/M109A3/M109A4 vehicles upon receipt. A run-in of at least 5 miles will be performed on all new or reconditioned vehicles, and of a sufficient number of miles on used vehicles, to check their operation completely. This section may provide material which is duplicated in the TM 9-2350-311-20-2 (M109A2/M109A3/M109A4 cab). This duplication is limited only to the activities which require crew and maintenance technicians' joint efforts.

2-6. INITIAL PROCEDURES

If the vehicle has been shipped by rail, unblock and unload the equipment according to Chapter 15. Observe existing regulations.

CHECKING UNPACKED EQUIPMENT

1 Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on SF 364 Form, Packing Improvement Report.

2 Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions in DA PAM 738-750.

3 Check whether the equipment has been modified. Reference shall be made to the authorized equipment configuration change list in Chapter 1.

4 Deleted

GENERAL HULL MAINTENANCE - SECTION II. SERVICE UPON RECEIPT - CONTINUED

2-6. INITIAL PROCEDURES - CONTINUED

DEPROCESSING UNPACKED EQUIPMENT

1 Install fire control and sighting equipment as is. No cleaning is required.

2 Clean all other tools and equipment.

3 Store all basic issue items in their respective vehicle storage facility as indicated on page 1-35 and TM 9-2350-311-10.

4 Clean the vehicle as follows:

WARNING

- Do not use mineral spirits or paint thinner to clean the howitzer. Mineral spirits and paint thinners are highly-toxic and combustible. Prolonged breathing can cause dizziness, nausea, and even death.
- Wear protective goggles and gloves when using dry-cleaning solvent. Use only in a well-ventilated area away from open flame or excessive heat. Failure to heed warning could cause severe injury or death.

Remove any rust-preventive compound from exterior surfaces with dry-cleaning solvent. Whenever possible, the vehicle crew will help in the cleaning.

Armament parts are coated with rust-preventive compound when received from storage. Clean these parts thoroughly with rags or a brush saturated with drycleaning solvent (Item 17, App. C). After complete removal of the rust-preventive compound, lubricate as specified in LO 9-2350-311-12. Component parts of each weapon should be cleaned separately where able. Component parts are interchangeable; however, the parts originally assembled work best together.

ASSEMBLY OF EQUIPMENT

The M109A2/M109A3/M109A4 hull equipment and systems are shipped as assembled units. Assembly is not required. However, assembly of hull components is discussed in detail in Chapters 4 through 11.1 of this manual. These chapters provide detailed information on removal, disassembly, assembly and installation of equipment for maintenance purposes.

EQUIPMENT INSTALLATION INSTRUCTIONS

Installation instructions for the M109A2/M109A3/M109A4 hull require installation of on-board vehicle equipment, equipment racks, and stowage of equipment in the hull as shown in Chapter 12. Installation of other components removed for maintenance purposes is discussed in detail in Chapters 4 through 11.1 of this manual.

Follow all precautions on DD Form 1397 (Processing and Deprocessing Record for Shipment, Storage, and Issue of Vehicles and Spare Engines). One tag will be with the Records Book and one in an envelope attached to a headlamp.

GENERAL HULL MAINTENANCE - SECTION II. SERVICE UPON RECEIPT - CONTINUED

2-7. PREOPERATIONAL PROCEDURES

Inspect all wires/hydraulic lines/connectors, electrical connectors, welds, bolts, and seals.

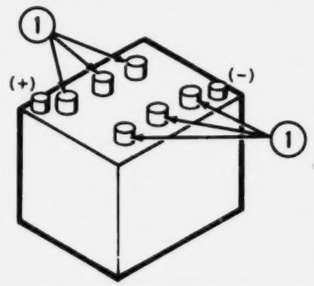
INSTALLATION OF BATTERIES

Install and service the batteries (ref. TM 9-2350-311-10 and TM 9-6140-200-14) as follows:

WARNING

Lead-acid battery gases can explode. Don't smoke, have open flames, or make sparks around a battery. SEVERE INJURY may result if you fail to heed this warning. Seek medical aid immediately should explosion occur.

Remove ground cables first when disconnecting batteries and install ground cables last when connecting batteries. When replacing batteries, connect them as shown in the battery hook-up diagram.



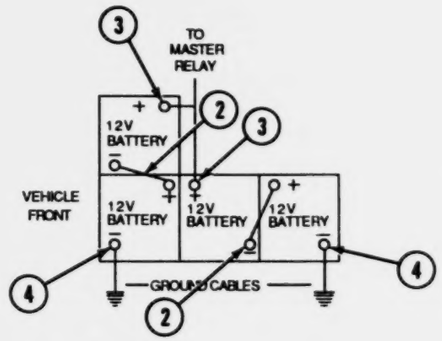
NOTE

If batteries are new and empty, notify Direct Support Maintenance to add electrolyte.

Remove six filler caps (1) from each battery. Fill each battery with distilled water, so that electrolyte level is above the top of battery plates. Replace filler caps.

TA471983

M109A2/M109A3

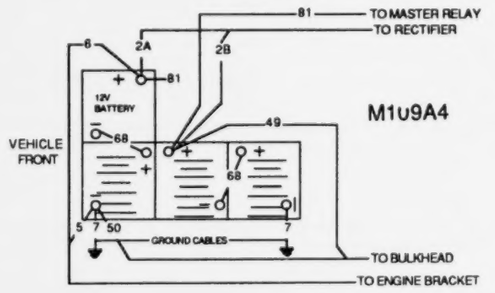


CAUTION

Ground straps must be disconnected before removal of battery cables or leads and connected after installation of cables to avoid possibility of arcing and damage to materiel.

For M109A2/M109A3 vehicles, install two battery cables (2). Install cable 81 on two positive terminals (3). Install two ground cables from terminals (4) to hull.

For M109A4 vehicles, install two battery cables (2). Install cables 81, 2A, 2B, 6, and 49 onto two positive terminals (3). Install cables 5 and 50 onto negative terminals (4). Install two ground cables from terminals (4) to hull.



TA471984

CHECKING VEHICLE SYSTEMS

Check for the following:

1 ENGINE COOLANT: Check level and specific gravity (ref. TM 9-2350-311-10 and p. 2-46, this manual).

2 ENGINE OIL: Check level (ref. LO 9-2350-311-12).

3 FUEL: Fuel vehicle (ref. LO 9-2350-311-12).

4 TRANSMISSION OIL: Check level (ref. LO 9-2350-311-12).

5 FIRE EXTINGUISHER BOTTLES: Check valve safety wire (ref. p. 2-48, this manual).

GENERAL HULL MAINTENANCE - SECTION II. SERVICE UPON RECEIPT - CONTINUED

2-8. OPERATIONAL PROCEDURES

Before starting vehicle, check TM 9-2350-311-10 for proper starting instructions.

INITIAL STARTING AND BREAK-IN

NOTE

Engine contains preservative oil upon receipt. Preservative engine oils PE1 and PE2 are identical to engine oils OE-10 and OE-30, except that they contain a preservative additive. PE1 and PE2 will be used in the same manner as the regularly used engine oils OE-10 or OE-30. PE1 or PE2 will also be used in the transmission until the first scheduled 2000-mile or semiannual oil change. Refer to LO 9-2350-311-12 for correct lubrication instructions.

1 Start and run engine until preservative oil is out of combustion chambers and engine is operating smoothly. Check for fuel and oil leaks immediately.

NOTE

Due to international processing, engine may be hard to start, and may smoke and run rough. Let it run for 5 minutes and see if it improves. Perform troubleshooting procedure if engine fails to develop full power after 5 minutes.

2 Perform complete annual service (ref. p. 2-34).

OPERATIONS TEST

Test vehicle systems for proper operation (ref. TM 9-2350-311-10).

ROAD TEST

Road test vehicle to check and qualify all operational systems (ref. TM 9-2350-311-10).

2-9. EQUIPMENT FAULTS

Equipment faults disclosed during preliminary inspection and servicing or during break-in period will be corrected by the using organization or supporting maintenance.

REPORTING DESIGN AND MATERIAL FAULTS

Serious equipment faults which appear to involve unsatisfactory design or material will be reported on SF 368, Quality Deficiency Report (Category II), as prescribed in DA PAM 738-750.

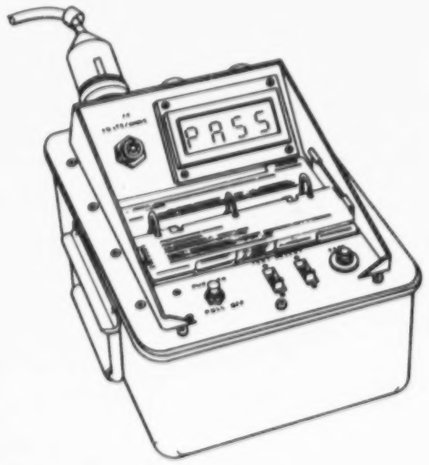
GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS

2-10. GENERAL

This section identifies operational check procedures and instructions for test and repair. Authorized crew and Organizational Maintenance are listed in Appendix B, Maintenance Allocation Chart.

Refer to Table of Contents (pages i through vii) for appropriate page references.

2-11. PERFORMING ELECTRICAL TESTS AND EQUIPMENT CHECKS



Perform electrical tests and equipment checks on the M109A2/M109A3/M109A4 vehicles with Simplified Test Equipment for Internal Combustion Engines (STE/ICE) and multimeters.

TA471985

STE/ICE or STE/ICE-R

STE/ICE or STE/ICE-R are portable diagnostic sets that can measure standard voltage, current, resistance, pressure, and speed of measurements of the M109A2/M109A3/M109A4 engine system. Equipment set up and testing procedures are covered in TM 9-4910-571-12&P.

MULTIMETERS

All necessary electrical checks and tests on the M109A2/M109A3/M109A4 can be performed with a multimeter. This section shows how to use the multimeter to find the cause of electrical problems in the M109A2/M109A3/M109A4 systems, and how to repair or replace electrical wiring and connectors in these systems. For troubleshooting the charging system, ref. DA PAM 750-33.

NOTE

Before using the multimeter, check the mechanical zero of the meter. If the meter pointer is not exactly over the zero line, reset by turning the adjusting screw set into the glass of, or just below, the meter face.

USING THE OHMS SCALE

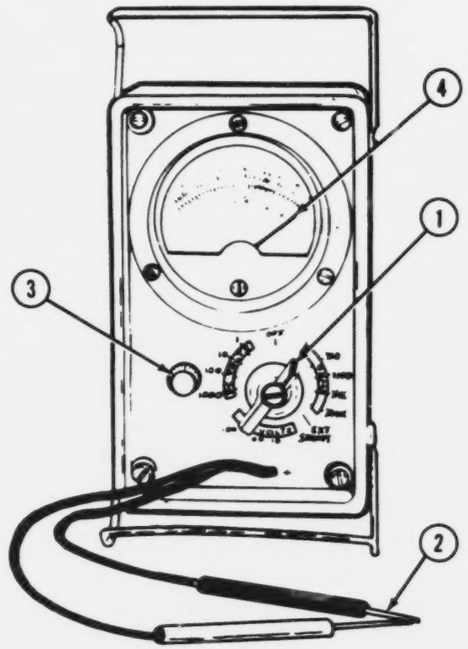
The ohms (Ω) scale is used to test for continuity, shorts, and resistance.

Proper operation of electrical components depends upon proper grounding. In all troubleshooting procedures of components which depend on screws or physical contact for their electrical ground (lamp sockets, transmitters, batteries, etc.), use a jumper wire from the device to the hull to check grounding.

Perform the following steps for the multimeter you are using.

GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-11. PERFORMING ELECTRICAL TESTS AND EQUIPMENT CHECKS - CONTINUED

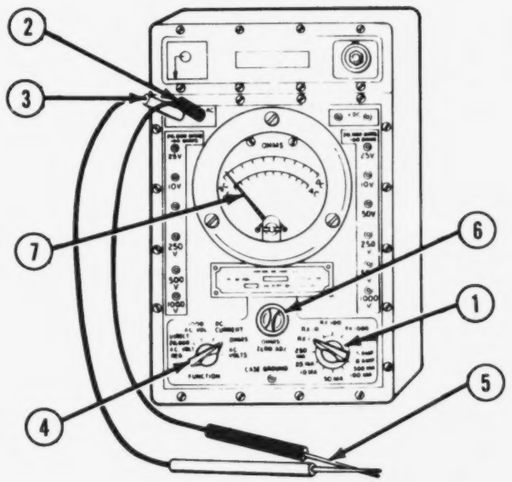


1 Set selector switch (1) to X1 ohms position.

2 Now zero the meter. Touch the two probes (2) together while turning ohms ADJ knob (3) until needle (4) is over 0 on the top scale.

3 If needle will not zero, replace the batteries. If needle still will not zero after replacing the batteries, turn in the multimeter for repair.

TA471986



TS-352 B/U

1 Set RANGE switch (1) on RX1.

2 Put black (-) lead (2) into the OHMS -DC+ AC jack.

3 Put red (+) lead (3) in the upper left OHMS jack.

4 Turn FUNCTION switch (4) to OHMS.

5 Touch the two probes (5) together.

6 Zero meter by turning the OHMS ZERO ADJ (6) knob until needle (7) is over 0 on top scale.

7 If needle will not zero, replace the batteries. If needle still will not zero after replacing the batteries, turn in the multimeter for repair.

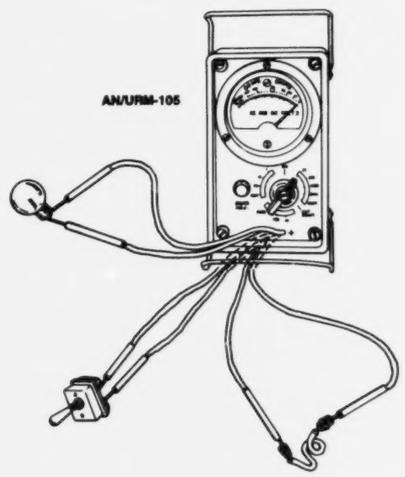
TA471987

GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-11. PERFORMING ELECTRICAL TESTS AND EQUIPMENT CHECKS - CONTINUED

TESTING FOR CONTINUITY

A continuity test checks for breaks in a circuit, such as the switch, light bulb, or electrical cable as shown. To make continuity checks, do the following steps:



1 Set up and zero the multimeter.

CAUTION

- Do not touch terminal caps with probes. This will give false reading and may damage the multimeter.
- Failure to do the following step can damage the multimeter.

2 Disconnect the circuit being tested from the power source. To be safe, disconnect the battery ground strap.

3 Connect the meter probes to both terminals of the circuit being tested. (The AN/URM-105 is illustrated, but the probes are connected to the circuit the same way with both multimeters.)

If the needle swings to the far right over the 0 on the top scale, the circuit has continuity.

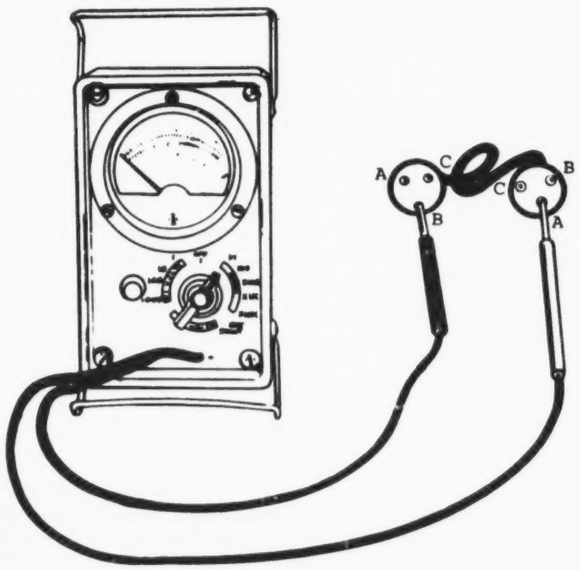
If the needle doesn't move, the circuit is open (broken).

If the needle jumps or flickers, there is a loose connection in the circuit being tested.

TA471988

TESTING FOR SHORT CIRCUITS

A short circuit occurs when two circuits (electrical leads/wires) which should not be connected have contact with each other. A short also occurs when a circuit that should not touch ground has contact with ground. To check for shorts, do the following steps:



1 Set up and zero the multimeter.

CAUTION

Failure to do the following steps can damage the multimeter.

2 Disconnect the circuit being tested from the power source. To be safe, disconnect the battery ground strap.

3 Connect one probe to one circuit and the other probe to the other circuit or ground (if checking for a short to ground). The example shows a check to see if wire A is shorted to wire B in the wiring harness.

4 Observe needle movement. If the needle swings to the far right over the 0 on the top scale, the circuits are short circuited.

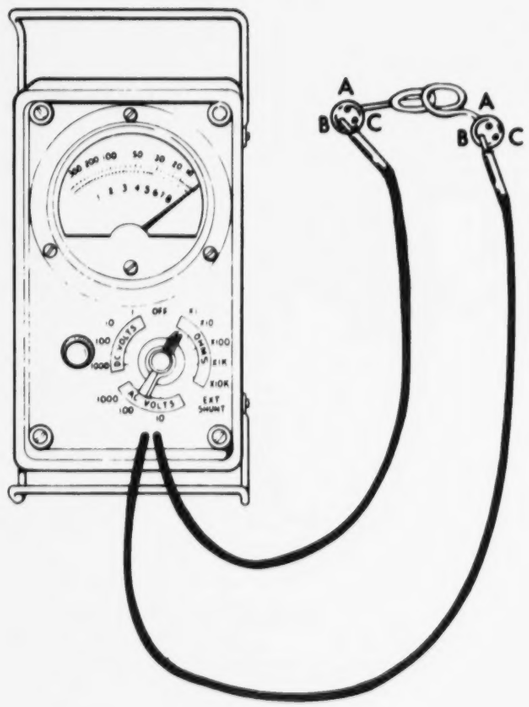
If the needle doesn't move, the circuits are not short-circuited.

If the needle jumps or flickers, the circuits are intermittently short-circuited.

TA471989

GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-11. PERFORMING ELECTRICAL TESTS AND EQUIPMENT CHECKS - CONTINUED



1 Set up and zero the multimeter.

CAUTION

Failure to do the following step can damage the multimeter.

2 Disconnect the circuit being tested from the power source. To be safe, disconnect the battery ground strap.

NOTE

Zero the meter every time you change ranges.

3 If the test calls for an ohms range different than RX1 or X1, set the selector switch to that range (like RX10 or X10).

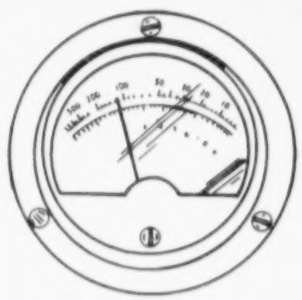
4 Connect the probes across the circuit or item to be measured. The example shows measuring the resistance of one wire in a three-wire cable.

TA471990

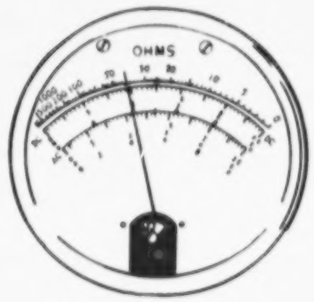
5 Read the meter. If the meter switch is on the RX1 or X1 range, the reading is taken directly from the top scale. If the meter switch is on a different range, multiply the reading on the scale according to the table below:

OHMS SWITCH SETTING	SCALE
X1 OR RX1	Read number on scale
X10 or RX10	Multiply reading by 10
X100 or RX100	Multiply reading by 100
X1K or RX1K	Multiply reading by 1000
X10K or RX10K	Multiply reading by 10,000

For example, the meters show the following readings:



AN/URM-105



TS-352 B/U

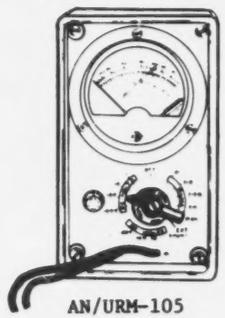
OHMS SWITCH SETTING	READING
X1	4 ohms
X10 or RX10	40 ohms

TA471991

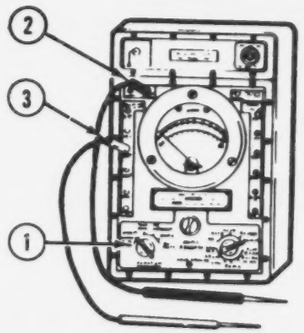
GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-11. PERFORMING ELECTRICAL TESTS AND EQUIPMENT CHECKS - CONTINUED

USING THE DC VOLTS SCALE



AN/URM-105



TS-352 B/U

CAUTION

Multimeter must be set to a voltage range higher than that being measured or multimeter could be damaged.

AN/URM-105

Set meter switch to DC volts range. (To measure 24 volts DC, set switch on 100 DC VOLTS range.)

TS-352 B/U

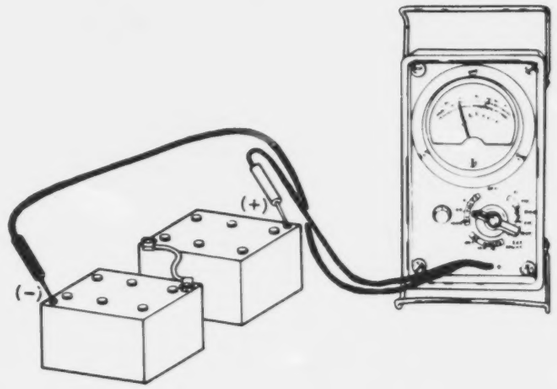
1 Set FUNCTION switch (1) to DIRECT.

2 Put black lead (2) in OHMS-DC/± AC jack.

3 To measure 24 volts DC, plug red lead (3) into 50V jack on left side of meter. (If measuring less than 10 volts DC, use 10V jack. If measuring less than 2.5 volts DC, use 2.5V jack.)

TA471992

MEASURING DC VOLTAGE



1 Set up and zero multimeter.

CAUTION

If you are unsure of the voltage to be measured on the vehicle, always start on the highest range. This will protect the meter from damage.

2 Connect the red probe to the positive (+) side of the circuit and the black probe to the negative (-) side. The example shows 24 volts DC being measured across the batteries.

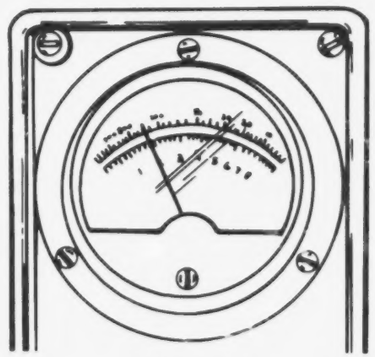
3 Read the meter. If the needle moves off scale to the left, check to insure that probes are connected per Step 2 above.

TA471993

GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-11. PERFORMING ELECTRICAL TESTS AND EQUIPMENT CHECKS - CONTINUED

MEASURING DC VOLTAGE - CONTINUED



AN/URM-105

NOTE

The following examples show how to read both multimeters.

AN/URM-105

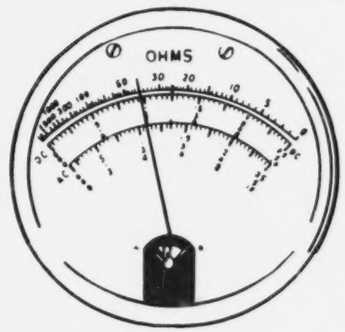
Read the DC volts scale for the range at which the selector switch is set.

SWITCH SETTING	SCALE
1000 DC VOLTS	0-10 (and multiply by 100)
100 DC VOLTS	0-10 (and multiply by 10)
10 DC VOLTS	0-10 (read the number on the scale)
1 DC VOLT	0-10 (and divide by 10)

Thus the meter illustrated is showing the following readings:

SWITCH SETTING	READING
1000 DC VOLTS	200 VOLTS DC
100 DC VOLTS	20 VOLTS DC
10 DC VOLTS	2 VOLTS DC
1 DC VOLT	0.2 VOLTS DC

TA471994



TS-352 B/U

TS-352 B/U

Read the DC volts scale for the range at which the red lead is plugged.

RANGE	SCALE
50V	0-5 (and multiply by 10)
10V	0-10 (read number on the scale)
2.5V	0-2.5 (read number on the scale)

Thus the meter illustrated is showing the following readings:

RANGE	READING
50V	20 volts DC
10V	4 volts DC
2.5V	1 volt DC

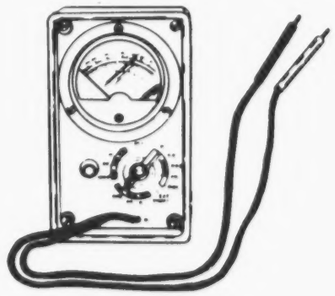
TA471995

GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-11. PERFORMING ELECTRICAL TESTS AND EQUIPMENT CHECKS - CONTINUED

USING THE AC VOLTS SCALE

The AC volts scale on the multimeter is used to measure the voltage in the alternator-to-rectifier circuit.

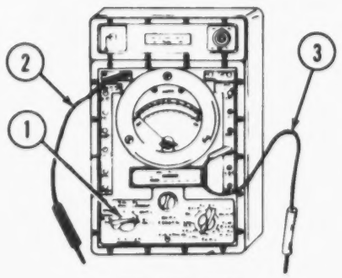


AN/URM-105

Before using the multimeter to measure AC volts, do the following steps for the multimeter you have.

AN/URM-105

Set meter switch to 1000 AC volts.



TS-352 B/U

TS-352 B/U

1 Set FUNCTION switch (1) to AC volts.

2 Put black lead (2) in OHMS-DC/±AC jack.

3 Put red lead (3) in 250V jack on right side of meter.

TA471996

2-12. WIRING HARNESS AND CABLE REPAIRS

Step-by-step procedures for the disassembly and assembly of typical receptacles, plugs, and cable connectors used on the M109A2/M109A3/M109A4 are shown here.

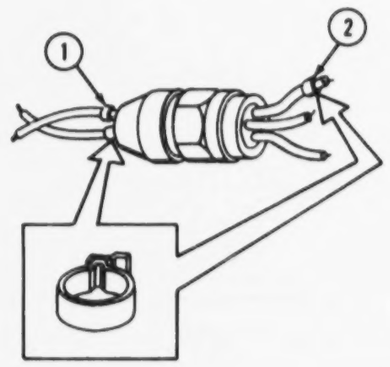
For any electrical repairs use TOOL KIT ELECTRIC: NSN 5180-00-876-9336.

For detailed instructions on soldering and solder see TB SIG 222.

CABLE WIRES, IDENTIFIERS, RECEPTACLES AND PLUGS

CAUTION

To avoid damaging wires, use resin core solder only.



NOTE

When removing more than one wire from a multiple wire receptacle, tag wires for later identification.

1 Cable identifiers (1) are aluminum tags attached to cables. These tags are embossed with the cable identification number. The identification number is the same number as shown on the systems wiring diagram.

2 Wire identifiers (2) are embossed with the individual wire number. The wire number is the same as shown on the systems wiring diagram.

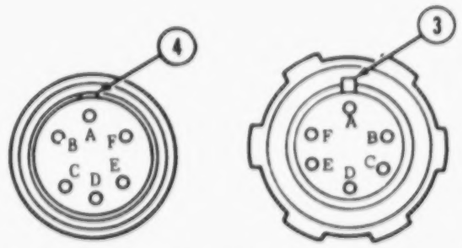
NOTE

If cables or wires are replaced, remove tags from old wire and place them on new wires.

TA471997

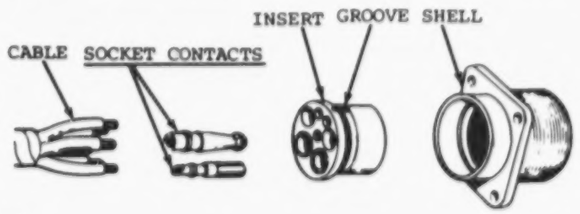
GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-12. WIRING HARNESS AND CABLE REPAIRS - CONTINUED



3 All pins (male connectors) and sockets (female connectors) in receptacles and plugs are identified by alphabetic code. Coded identification starts at the connector key (3) or groove (4) and for:
- Male connectors identifying letters run clockwise.
- Female connectors identifying letters run counterclockwise.

TYPICAL FEMALE-TYPE PANEL MOUNTING RECEPTACLE: DISASSEMBLY AND ASSEMBLY



DISASSEMBLY

1 Drive socket contact out through rear of insert with pin extractor.

2 Unsolder cable leads from solder wells on socket contacts.

3 Slide insert out through rear of shell.

ASSEMBLY

1 Strip cable insulation equal to depth of solder wells of socket contacts.

2 Insert cable leads into solder wells of socket contacts and solder using resin core solder.

3 Push insert into shell from rear until seated. Groove in insert must be alined with guide in shell to ensure proper fit.

4 Push socket contacts into insert from rear until seated.

TA471998

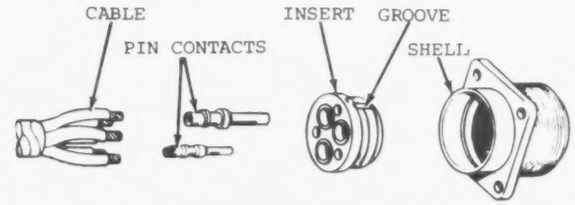
TYPICAL MALE-TYPE PANEL MOUNTING RECEPTACLE: DISASSEMBLY AND ASSEMBLY

DISASSEMBLY

1 Drive pin contacts out through rear of insert with pin extractor.

2 Unsolder cable leads from solder wells on pin contacts.

3 Slide insert out through rear of shell.



ASSEMBLY

1 Strip cable insulation equal to depth of solder wells of pin contacts.

2 Insert cable leads into solder wells of pin contacts and solder using resin core solder.

3 Push insert into shell from rear until seated. Groove in insert must be alined with guide in shell to ensure proper fit.

4 Push pin contacts into insert from rear until seated.

TA471999

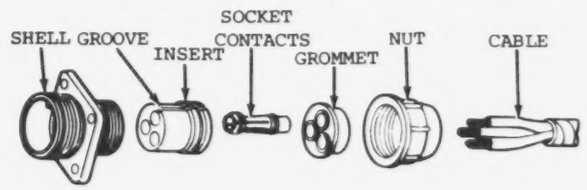
GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-12. WIRING HARNESS AND CABLE REPAIRS - CONTINUED

TYPICAL FEMALE-TYPE PANEL MOUNTING RECEPTACLE: DISASSEMBLY AND ASSEMBLY WITH RIDGED LOCKING NUT

DISASSEMBLY

1 Unscrew nut from shell assembly and slide back on cable.
2 Slide grommet back on cable leads.
3 Drive socket contacts out through front of insert with pin extractors.
4 Unsolder leads from socket contacts.
5 Push insert out through rear of shell.



ASSEMBLY

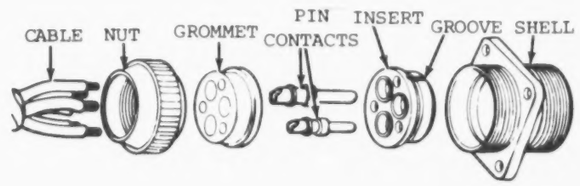
1 Strip cable insulation equal to depth of solder wells of socket contacts.
2 Slide nut over cable.
3 Slide grommet over cable leads.
4 Insert cable leads into solder wells of socket contacts and solder using resin core solder.
5 Push insert into shell from rear until seated. Groove in insert must be alined wih guide in shell to ensure proper fit.
6 Push socket contacts into insert from rear until seated.
7 Push grommet down cable leads and over solder wells of socket contacts.
8 Screw nut onto shell assembly.

TA472000

TYPICAL MALE-TYPE PANEL MOUNTING RECEPTACLE: DISASSEMBLY AND ASSEMBLY WITH RIDGED LOCKING NUT

DISASSEMBLY

1 Unscrew nut from shell assembly and slide back on cable.
2 Push grommet back on cable leads.
3 Drive pin contacts out through rear of insert with pin extractor.
4 Push insert out through rear of shell.
5 Unsolder leads from pin contacts.



ASSEMBLY

1 Strip cable insulation equal to depth of solder wells of pin contacts.
2 Slide nut onto cable.
3 Slide grommet over cable leads.
4 Insert cable leads into solder wells of pin contacts and solder using resin core solder.
5 Push insert into shell from rear until seated. Groove in insert must be alined with guide in shell to ensure proper fit.
6 Push pin contacts into insert from rear until seated.
7 Push grommet down cable leads and over solder wells of pin contacts.
8 Screw nut onto shell assembly.

TA472001

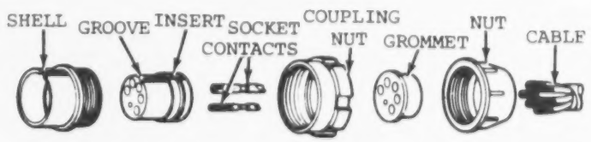
GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-12. WIRING HARNESS AND CABLE REPAIRS - CONTINUED

TYPICAL FEMALE-TYPE PLUG: DISASSEMBLY AND ASSEMBLY WITH RIDGED LOCKING NUT

DISASSEMBLY

1 Unscrew nut from shell assembly and slide back on cable.
2 Slide grommet back on cable leads.
3 Slide coupling nut off shell.
4 Drive socket contacts out through rear of insert with pin extractor.
5 Push insert out through rear of shell.
6 Unsolder leads from socket contact.



ASSEMBLY

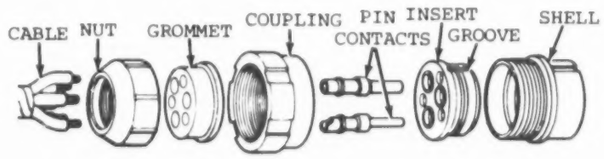
1 Strip cable insulation equal to depth of solder wells of socket contacts.
2 Slide nut over cable leads.
3 Slide grommet over cable leads.
4 Insert cable leads into solder wells of socket contacts and solder using resin core solder.
5 Push insert into shell from rear until seated. Groove in insert must be alined with guide in shell to ensure proper fit.
6 Push socket contacts into insert rear until seated.
7 Slide coupling nut onto shell assembly.
8 Push grommet down cable leads and over solder wells of socket contacts.
9 Screw nut onto shell assembly.

TA472002

TYPICAL MALE-TYPE PLUG: DISASSEMBLY AND ASSEMBLY WITH RIDGED LOCKING NUT

DISASSEMBLY

1 Unscrew nut from shell assembly and slide back on cable.
2 Slide grommet back on cable leads.
3 Slide coupling nut off shell assembly.
4 Drive pin contacts out through rear insert with pin extractor.
5 Push insert out through rear of shell.
6 Unsolder cable leads from pin contacts.



ASSEMBLY

1 Strip cable of insulation equal to depth of solder wells of pin contact.
2 Slide nut over cable.
3 Slide grommet over cable leads.
4 Insert cable leads into solder wells of pin contacts and solder using resin core solder.
5 Push insert into shell from rear until seated. Groove in insert must be alined with guide in shell to ensure proper fit.
6 Push pin contacts into insert from rear until seated.
7 Slide coupling nut onto shell assembly.
8 Push grommet down cable leads and over solder wells of pin contacts.
9 Screw nut onto shell assembly.

TA472003

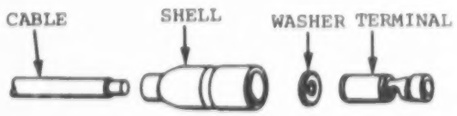
GENERAL HULL MAINTENANCE - SECTION III. OPERATIONAL CHECKS - CONTINUED

2-12. WIRING HARNESS AND CABLE REPAIRS - CONTINUED

CABLE TERMINALS AND CONNECTORS: REPLACEMENT TERMINAL-TYPE CABLE CONNECTOR

1 Strip cable insulation equal to depth of terminal well.
2 Slide insulator over cable.
3 Insert cable into terminal well and crimp.
4 Slide insulator over crimped end of terminal.

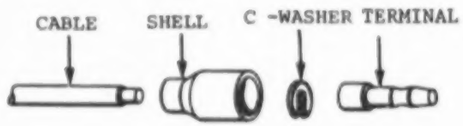
FEMALE CABLE CONNECTOR (WITH WASHER)



1 Strip cable insulation approximately 1/8-inch (3.2-mm).
2 Slide shell and washer over cable.
3 Place cable in cylinder end of terminal and crimp.
4 Slide shell and washer over terminal.

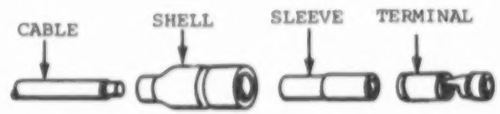
TA472004

MALE CABLE CONNECTOR (WITH WASHER)



1 Strip cable insulation equal to depth of terminal well.
2 Slide shell over cable.
3 Insert cable into terminal well and crimp.
4 Place C-washer over cable at crimped junction and slide shell over C-washer and terminal.

FEMALE CABLE CONNECTOR (WITH SLEEVE)



1 Strip cable insulation approximately 1/8-inch (3.2-mm).
2 Slide shell and sleeve over cable.
3 Place cable in cylinder end of terminal and crimp.
4 Slide shell and sleeve over terminal.

TA472005

GENERAL HULL MAINTENANCE - SECTION IV. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-13. GENERAL

This section contains Organizational preventive maintenance checks and services.

Preventive maintenance is the step-by-step care, inspection, and service of equipment to maintain it in good condition and to find problems before extensive and time-consuming repairs or replacements are needed. Refer to DA PAM 738-750 for instructions on use of forms for preventive maintenance services.

INTERVALS

The preventive maintenance checks and services listed in Table 2-1 are to be performed at organizational level at intervals determined by whichever comes first: (a) semiannually, 1500 miles, or 150 hours;(b) annually, 3000 miles, or 300 hours.

Preventive maintenance checks and services items and intervals have been determined by using Reliability Centered Maintenance (RCM) logic and are to be scheduled on DD Form 314 in accordance with DA PAM 738-750.

After operation in water, mud, and loose sand, the vehicle should be cleaned as soon as possible. Lubricate without waiting for the next scheduled service.

LUBRICATION ORDER

LO 9-2350-31' 2 has detailed lubrication steps and instructions covering locations, intervals, and lubricants f' M109A2/M109A3/M109A4 vehicles. The crew will assis the Organizational Maintenance personnel ir bricating the vehicle.

PROCEDURES

Routine applications. TM 9-2350-311-10 contains maintenance instructions which the Organizational mechanic must use to perform his duties.

Crew participation. The crew will accompany the vehicle and help the Organizational mechanics perform the Organizational services.

Vehicle cleanliness. The crew should bring a clean vehicle to a scheduled preventive maintenance service. It should be dry and not caked with mud. Washing the vehicle should not be done just before an inspection. Some defects, such as loose parts and oil leaks, may not be noticed immediately after washing.

CAUTION

Do not direct a stream of water or steam against the opening between the hull and cab (cab race ring), grilles exhaust deflectors, fire control, or armament openings.

SERVICES

Organizational services are defined by, and limited to, the following general procedures. Approval to perform higher category services must be given by the supporting maintenance unit.

Adjustment. Make all needed adjustments using instructions in this manual and/or technical bulletins.

Cleaning. Clean the unit to remove old lubricant, dirt, and other foreign matter. Special cleaning instructions are given as needed.

Special lubrication. Special lubrication applies either to lubrication operations that do not appear in LO 9-2350-311-12 or to items that do appear, but which should be done with the annual service.

Service. Servicing covers operations such as adding battery water, draining and refilling units with oil and changing or cleaning the oil filters, fuel filters and air cleaners.

Tightening. All tightening operations should be done according to specified torque readings where noted in this manual. When torque isn't specified, care should be taken not to strip or distort threads by overtightening. Use a torque wrench where specified. Tightening includes the correct installing of lockwasher, nut, lockwire, or cotter pin needed to secure the tightened nut or bolt in place. Refer to p. 2-59 for torque requirements.

Repair. Restore an item to a serviceable condition. This includes, but is not limited to, inspection, cleaning, preserving, adjusting, replacing, welding, riveting and strengthening.

GENERAL HULL MAINTENANCE - SECTION IV. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS) - CONTINUED

2-14. PROCEDURES FOR SEMIANNUAL/ANNUAL SERVICES

DA Form 2404, Equipment Inspection and Maintenance Worksheet, is used by the mechanic to record periodic maintenance services performed and faults corrected. The item number on the DA Form 2404 must correspond to the item number of the preventive maintenance check.

Specified items to be checked semiannually and annually are found in Table 2-1, p. 2-36.
Before you begin to check specific items, remember to check things common in all areas as shown in the following illustrations:

NOTE

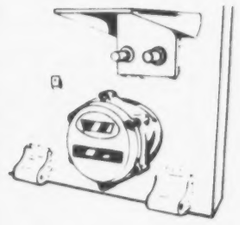
Perform Organizational Maintenance level repair or replacement as authorized. Report faulty equipment which is beyond Organizational Maintenance level as prescribed in DA PAM 738-750.

ELECTRICAL WIRES AND CONNECTORS

Electrical wiring should be checked for cracks due to aging and for exposed wires which cause electrical shorts. Repair with electrical tape or replace. Check connectors and tighten if loose (complete hull wiring diagram, harnesses and detail in Chapter 8 of this manual).

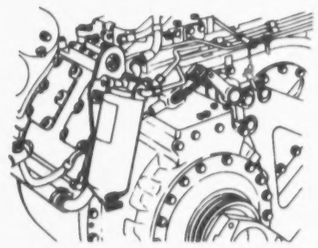
TA472006

WELDS



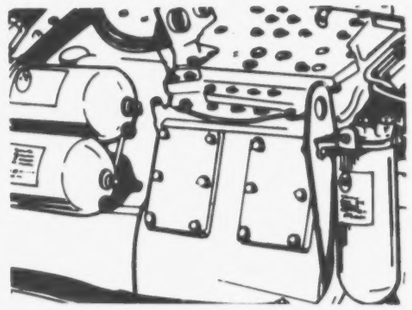
Many items are attached to the hull with welds. Check for damaged welds by looking for chipped paint or oxidation. Make repairs if authorized.

SEALS



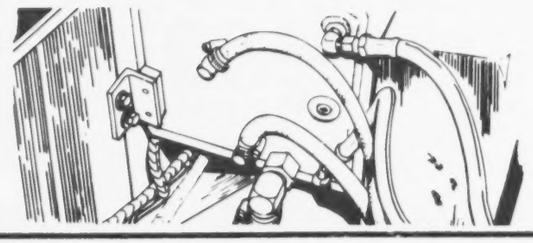
Check for leaks around seals. Check gasket material. Check door and hatch seals. Check for deterioration, cracks and tears.

BOLTS



Check for loose bolts. A loose bolt can be difficult to spot without actually applying a wrench. You can often tell by loose or chipped paint around the bolt head and bare metal or oxidation present at the base of the bolt head.

HOSES AND FLUID LINES



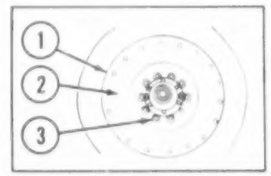
Check all hoses and lines for signs of wear (deterioration or cracks), leaks, loose clamps, and loose fittings. A stain around a fitting is a sign of a leak. Tighten, repair, or replace hoses and fittings.

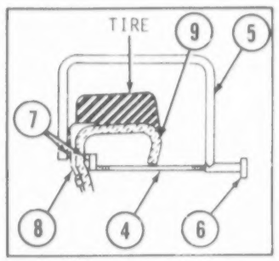
TA472007

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

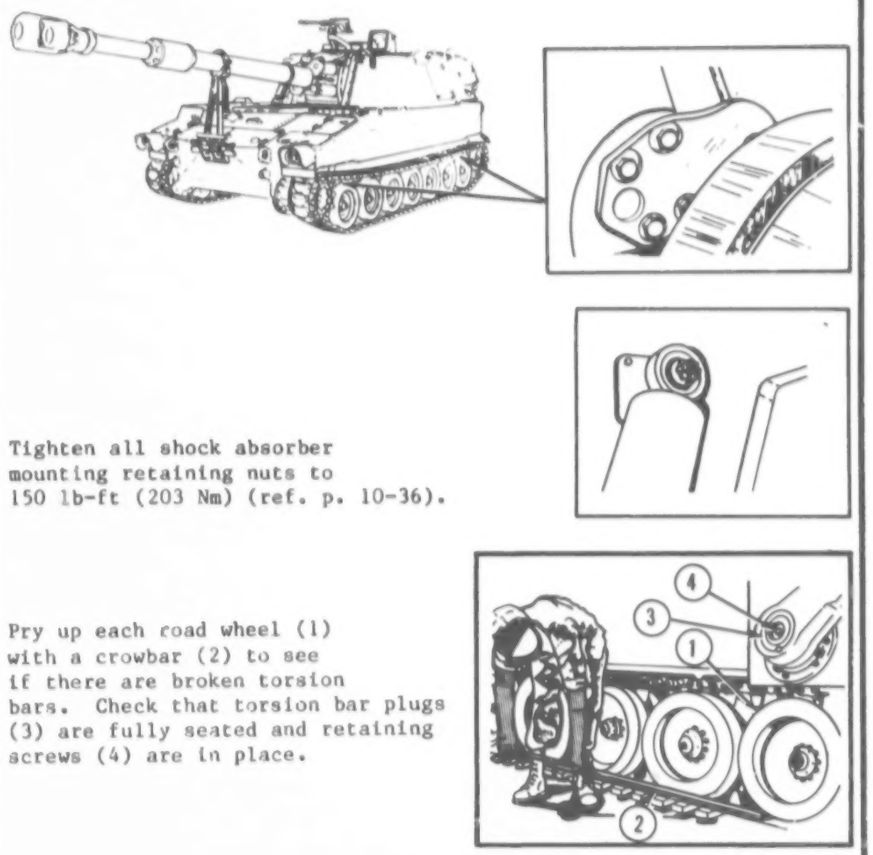
ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
1		•	LUBRICATION	Perform lubrication as required by LO 9-2350-311-12.
2		•	ROAD WHEELS AND IDLER WHEELS	Inspect road wheels for rubber separation (1) and missing rubber chunks that may cause thumping. Check for cracks in wheel (2). Tighten nuts (3) to 180 lb-ft (243 Nm) on torque wrench. Measure road wheel wear as follows: A. Pull out threaded rod (4) and place gage (5) (Item 11, App. B) over road wheel as shown, backing off knurled knob (6) as required. B. When gaging balls (7) are in contact with wear ring (8) and inside of wheel disk (9), slowly turn knurled knob (6) clockwise until it just contacts rod housing. Do not tighten knob, since this will pull inner gage ball (7) away from wheel disk (9). C. Pull rod (4) back, without disturbing knob (6), until gage can be removed from the wheel. D. Push rod in until knob contacts housing. Measure dimension between gaging balls. E. If the dimension between balls is 7/16 inch (11 mm) or less, the road wheel should be replaced.





TA472008

	3		•	BUMP STOP BRACKETS	Tighten bump stop mounting bracket bolts 300-350 lb-ft (405-473 Nm).
	4		•	SHOCK ABSORBERS	Tighten all shock absorber mounting retaining nuts to 150 lb-ft (203 Nm) (ref. p. 10-36).
	5		•	TORSION BARS	Pry up each road wheel (1) with a crowbar (2) to see if there are broken torsion bars. Check that torsion bar plugs (3) are fully seated and retaining screws (4) are in place.

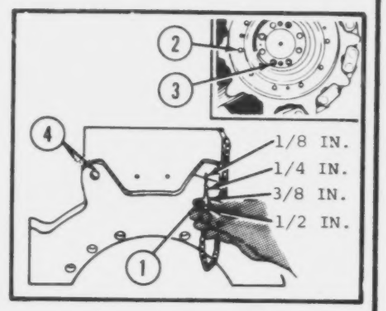


TA472009

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL		ITEM TO BE INSPECTED	PROCEDURES
	S	A		
6		•	DRIVE SPROCKET AND HUBS	Place gage (1) (Item 43, App. B) between two sprocket teeth and measure. Reverse sprockets when wear on drive side is 1/2 inch (12.7 mm). Replace sprockets when wear is 1/2 inch (12.7 mm) on each side of teeth or when the track shoe center guide contacts the sprocket hub. Always reverse hubs with sprockets. Check mounting bolts (2) for 90 lb-ft (122 Nm) torque and hub bolts (3) for 450-475 lb-ft (607-641 Nm) torque. OR Check wear marks (4). If sprocket tooth is worn to mark, reverse sprockets. Replace sprocket when tooth is worn to the mark on both edges.



TA472010

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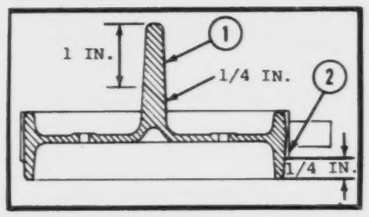
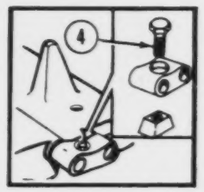
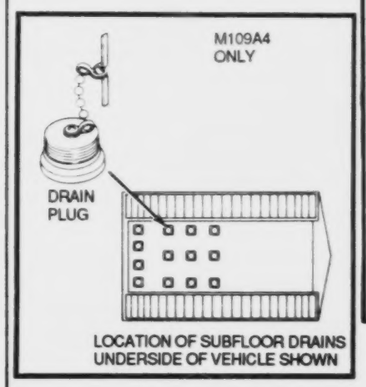
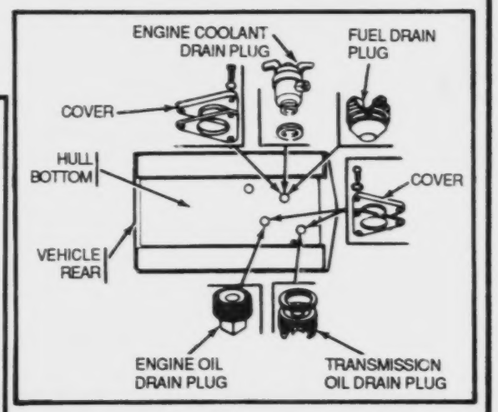
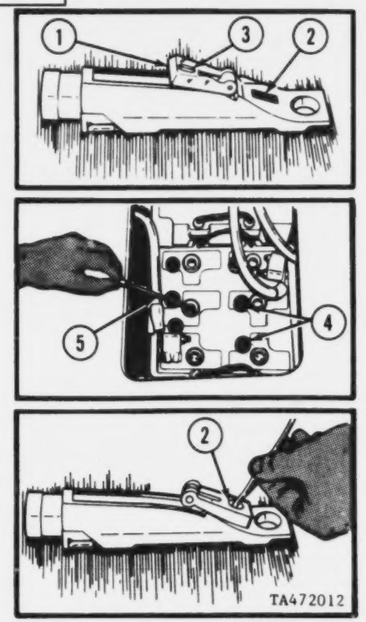
7		•	TRACKS	Measure thickness of center guide (1) at a point one inch (2.5 cm) from end. Replace track block, if center guide measures less than 1/4 inch (6.4 mm) or grouser (2) measures less than 1/4 inch (6.4 mm). Replace pads (3) when worn even with metal grouser (2). Tighten connector screws (4) to 85 lb-ft (115 Nm) at idler when track shoe angle is at center rear of idler wheel.	 
8		•	DRAIN COVERS AND PLUGS	Replace or secure drain covers and plugs on underside of hull.	 

TA472011

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
9	•		BATTERIES	**WARNING** Battery gases can explode. Do not smoke, have open flame or create sparks around a battery. Severe injury may result due to explosion. Perform STE/ICE battery testing (ref. p. D-70). If STE/ICE is unavailable, test specific gravity of each battery with duo-tester (Item 42, App. B) as follows: A. Swing plastic cover (1) back on duo-check coolant and battery to clean the measuring surface (2) and the bottom cover (3) with a clean soft cloth. Close cover plate. B. Remove battery caps (4) from all cells. Repeat steps C through E for each cell. C. Use dipstick (5) to obtain a small sample of battery acid. D. Place a few drops of acid onto measuring surface (2) through opening in cover plate.

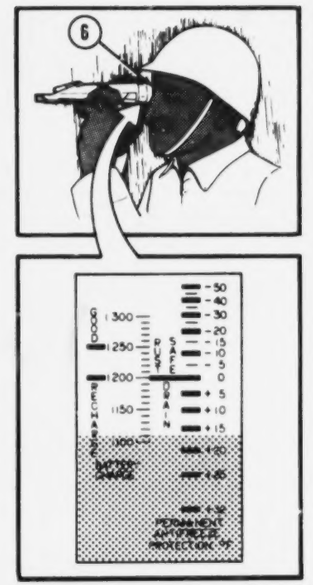


E. Point the instrument toward any light source (headlight) and look into eyepiece (6). The battery charge is at a point on the left part of the scale where the dividing line between light and dark (shadow) crosses the scale.

The illustration shows a reading of 1.120 specific gravity points, which indicates that the battery requires recharging.

NOTE

A little experience will enable you to quickly obtain the best contrast between light and dark portions of the field of view. Tilt the instrument toward the light source until the best results are obtained. If the edge of the shadow is not sharp, the measuring surface was not sufficiently cleaned or dried.



10	•		FUEL SYSTEM	Check all connections (1) for evidence of leaks. Change fuel filter elements (primary and secondary) (2) (ref. p. 6-14 through 6-17), and personnel heater fuel filter element (3) (ref. p. 11-54).

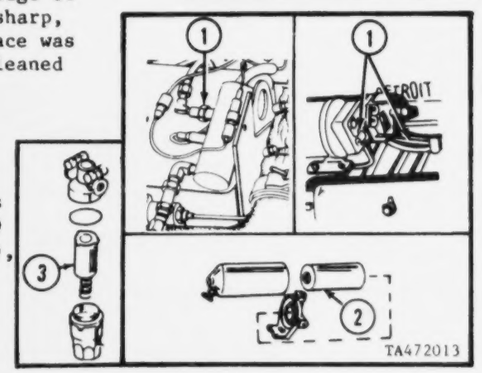
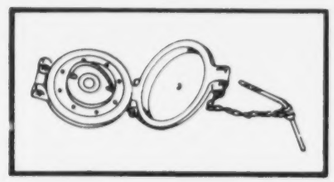
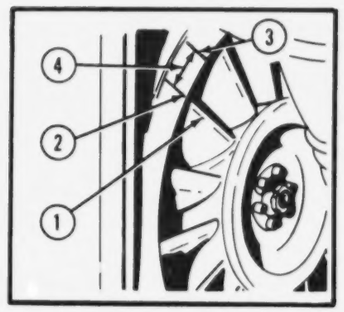
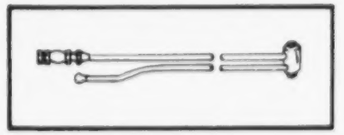


TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
11		•	FUEL FILLER NECK SEAL	**NOTE** Some M109A3 may have an inflatable seal. If so, inflate seal to 10 psi (0.7 Kg/cm^2). Check for cracks in rubber and for missing screws. 
12	•		ENGINE FAN DRIVE SYSTEM	Perform backlash test as follows: A. Disconnect both battery ground cables. B. Open air intake grille. C. Mark any accessible blade (1). D. While holding the opposite fan impeller, rotate the marked blade as far left as possible. Mark the fan housing directly above the blade mark (3). E. While holding the opposite fan impeller, rotate the marked blade as far right as possible. Mark the fan housing directly above the blade mark (3). 

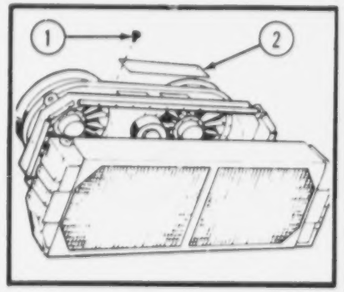
TA472014

					F. Measure the distance between marks (2) and (3). If distance (4) is over one inch (2.5 cm), backlash is excessive. Notify Direct Support Maintenance if this condition exists. Inspect fan for a cracked rubber boot, or loose boot retaining rings on boot covering the drive shaft U-joints. Notify Direct Support maintenance if rubber boot is cracked or retaining ring is loose.
	13		•	COOLING SYSTEM RADIATOR HOSES AND PUMPS	**WARNING** Do not remove a radiator cap from a warm engine. Coolant can burn severely. Check for cracked, weak or broken hoses. Check coolant system for leakage. Check coolant level. Remove shroud cover and inspect drive shafts for excessive wear and loose rubber boots.  The radiator should be cleaned with a radiator cleaning tool and a cleaning agent which removes deposits of sand, oil, clay and other debris from the radiator cooling fins while installed in the vehicle. Clean radiator as follows:

TA472015

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
13		•	COOLING SYSTEM RADIATOR HOSES AND PUMP - CONTINUED	**NOTE** The cleaning agent can be a solution of detergent and water or of non-toxic, nonflammable solvent and water. Mix one part of detergent or solvent to container. Clean radiator as follows: A. Remove eight screws (1) and shroud cover (2). B. Open hull drains. C. Cover all exposed openings of the engine. D. Connect tool to air supply and insert liquid supply hose into container of cleaning solution. E. Insert tool through shroud cover opening and wet front and back of radiator with cleaning solution. Soak for approximately 10 minutes. F. Remove heavy deposits from face of radiator by brushing with medium stiff brush that will not damage the fins.  TA472016

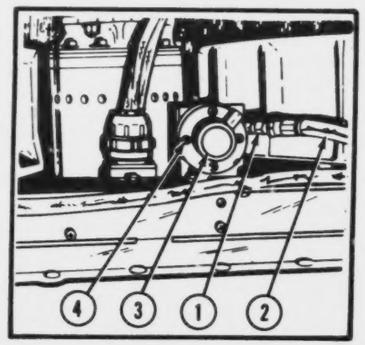
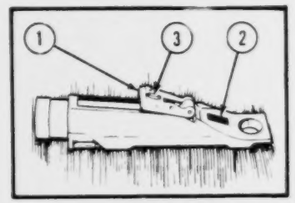
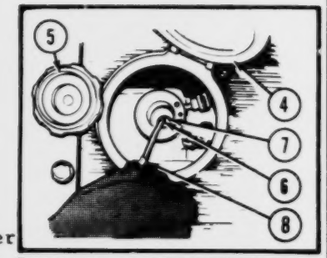
					G. Blast radiator with air/solution mixture, holding head of tool approximately 1/2 inch (12.7 mm) from face of radiator. Alternate from back to front until cleaning solution flows smoothly through the radiator. H. Drain the container and fill with clean water. Flush engine parts and radiator completely. Remove liquid supply hose from container and use air to complete the operation. I. Uncover engine openings and install radiator shroud cover with eight screws. Close hull drains.
14		•	COOLING SYSTEM PRESSURE VALVE	Remove and clean pressure relief valve as follows: A. Unscrew nut (1) and remove hose (2) from lower end of relief valve (3). B. Remove four screws (4). Lift off relief valve (3). C. Wipe off accumulation of rust. Depress spring to ensure it is not broken. D. To install pressure relief valve, reverse removal procedures (ref. p. 7-11).	**NOTE** Location of pressure relief valve is different on M109A2/ M109A3 and M109A4 vehicles.  TA472017

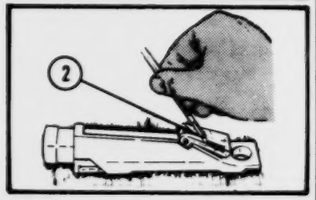
TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
15		•	COOLANT	Test radiator coolant for proper protection as follows: A. Swing plastic cover (1) back on duo-check coolant and battery tester (Item 42, App. B). Clean the measuring window (2) and bottom of plastic cover (3) with a soft clean cloth. **WARNING** Do not remove a radiator cap from a warm engine. Hot coolant can burn severely. Insure engine is cool. B. Open radiator access cover (4) and slowly remove radiator cap (5). Coolant should be visible. If not, start engine and slowly add coolant until it reaches the top of the filler neck. Run engine until new coolant is mixed with old coolant. C. Insert tip of bulb pump (6) into a radiator filler neck (7) well below the coolant surface level. Squeeze and release bulb (8) to draw up sample of coolant.







TA472018

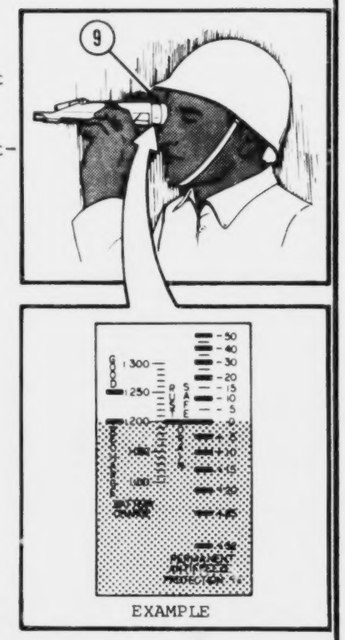
D. Squeeze bulb (8), ejecting a few drops of coolant onto the measuring window (2).

E. Point the instrument toward any light source (headlight) and look into the eyepiece (9). The antifreeze protection is at a point on the right-hand part of the scale where the dividing line between light and dark (shadow) crosses the scale. Example as follows:

The illustration shows a reading of $0^{\circ}F$ ($-18^{\circ}C$).

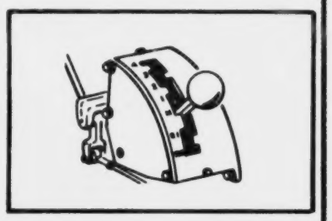
NOTE

A little experience will enable you to quickly obtain the best contrast between the light and dark view. Tilt the instrument toward the light source until the best results are obtained. If the edge of the shadow is not sharp, the measuring surface was not sufficiently cleaned or dried.



EXAMPLE

16		•	TRANSMISSION	Move transmission shift control lever to all positions. The shift control lever should not bind. If binding occurs, adjust as prescribed on p. 9-19.

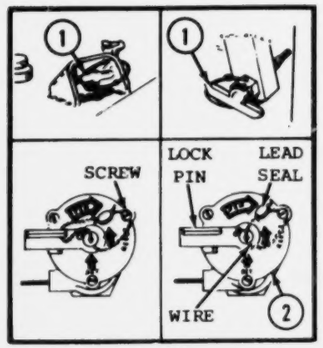


TA472019

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

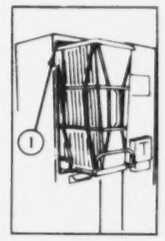
S-SEMIANNUALLY A-ANNUALLY

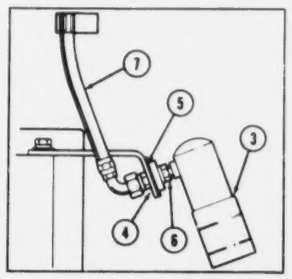
ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
17	•		FIRE EXTINGUISHER SYSTEM	**WARNING** Cylinders must not be dropped, struck, or subject to any temperature above +140°F (60°C). An explosion may result causing severe injury or DEATH. Remove and weigh cylinders. Cylinders are to be recharged to the "FULL" weight stamped on cylinder if the difference between the "FULL" and "CURRENT" (after weighing) weight exceeds one pound. Before replacing cylinder, operate the discharge handles (1) to ensure the cables do not bind. Replace safety seal and wire on control valve (2). Driver's and outside handles require safety wire and seal (ref. p. 11-60). Inspect fire extinguisher cylinder data plates to ensure that a hydrostatic test has been performed within the past 5 years. Faulty extinguishers or those past the test time limit (5 years) shall be declared unserviceable and replaced.



TA472020

18	•		AIR CLEANER FILTER	**WARNING** If NBC exposure is suspected, all air filter media will be handled by personnel wearing full NBC protective equipment. Check for worn or missing seals (1) and hoses (2). Check blower motors for operation. Troubleshoot if necessary (ref. p. 3-38). Clean, repair or replace motors, seals, and filter packs as required (ref. p. 6-28). Clean as follows: A. On late design (A), use compressed air only. On early design (B), use either air or non-sudsing detergent. **NOTE** Filter element must be thoroughly dry before installation. B. Fan element and shake out dust. Replace filter elements which have holes or ruptures.
19	•		AIR CLEANER	Check indicator casing (1) for damage and corrosion. Check to see that bracket (2) is secure. Check gasket (3) for signs of corrosion. Check nut (4) for tightness. Check hose (5) for leaks.





TA472021

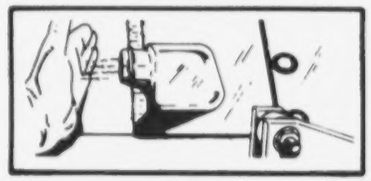
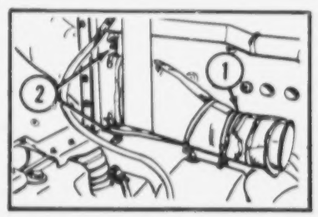
TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

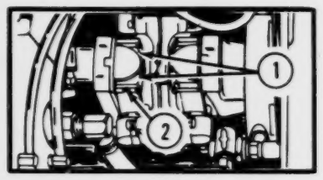
ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
20		•	NEUTRAL SAFETY SWITCH	Clear personnel and equipment from near vehicle. Apply the brakes and pull out the fuel shut-off control. Attempt to crank the engine. If starter engages, stop immediately and follow the troubleshooting procedures on p. 3-16. Check for proper operation of the starter protection relay.
20.1		•	STARTER PROTECTION RELAY	A. Pull fuel shut off to prevent engine from starting during the procedure (ref. TM 9-2350-311-10). B. Engage starter (ref. TM 9-2350-311-10). Note the amount of time that the starter cranks and when it stops. C. If starter cranks for only 1 to 2 seconds, troubleshoot batteries for low power (ref. p. 3-11). D. If the starter cranks longer than the listed times, refer to starter protection circuit troubleshooting (ref. p. 3-16). E. If the starter cranks for the listed times, wait one minute and try to engage again. If the starter operates, troubleshoot starter protection circuit (ref. p. 3-16).

TEMPERATURE	TIME
-65° to 0° F -10° to -18° C	120 sec. ± 20 sec.
0° to 50° F -18° to 10° C	60 sec. ± 9 sec.
50°F and greater 10°C and greater	30 sec. ± 5 sec

TA472022

					CAUTION Override switch should be used only in an emergency or when tested as in this step. Excessive use may cause damage to the starter. F. Place starter protection override switch ON (ref. TM 9-2350-311-10) and engage starter for five seconds or less. If starter does not operate, troubleshoot starter protection circuit (ref. p. 3-16). G. Place combat override switch OFF. Release fuel shut off handle and attempt to start engine. If starter engages before 2.0 - 2.8 minutes have elapsed since step B, troubleshoot starter protection circuit (ref. p. 3-16).
21		•	ENGINE	Perform STE/ICE PMCS testing (ref. p. D-9).	
22		•	BILGE PUMP	**CAUTION** Do not dry test bilge pump longer than 1 minute. Dry test bilge pump by turning it on. Air should be felt at outlet.	
23		•	EXHAUST DUCTS	Replace damaged components. Check all clamps (1) and mounting bolts (2).	
24	•		FUEL TANK AND HEAT SHIELD	Inspect the upper fuel tank and the upper fuel tank heat shield for damage. Check condition and tightness of all seals and fasteners (ref. p. 6-40).	

25		•	FINAL DRIVE UNIVERSAL JOINTS	Check for missing or broken wires (1). Tighten mounting bolts (2) to 90±10 lb-ft (122 Nm).
	•			Remove end cover. Inspect the bearing retaining nut. If there are visual signs of loose nut or sheared cotter pin, the final drive will be removed and replaced.



NOTE

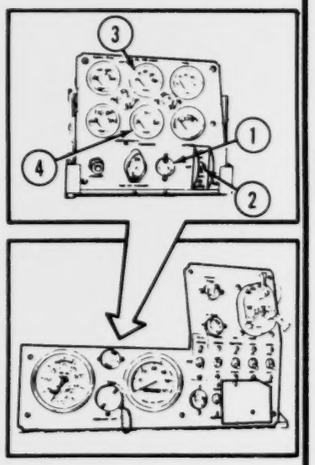
Perform road test to check items 25 through 27.

26		•	INSTRUMENT PANEL	Check all lights and gages for proper operation. Follow troubleshooting procedures in Chapter 3 if malfunction appears.

A. MASTER switch indicator (1) should light when MASTER switch (2) is on.

B. ENGINE OIL PRESSURE gage (3) should read:
30 to 50 pounds per square inch gage (psig) (2.1 to 3.5 Kg/cm^2) while engine is running at 1000 rpm;
50 to 70 psig (3.5 to 5.0 Kg/cm^2) while engine is operating at 2100 rpm;
70 psig (5 Kg/cm^2) maximum.

C. TRANSMISSION OIL PRESSURE gage (4) should read:
18 to 45 psig (1.3 to 3.2 Kg/cm^2) while engine is operating at 1835 to 1900 rpm;
10 psig (0.7 Kg/cm^2) minimum at 1000 rpm.

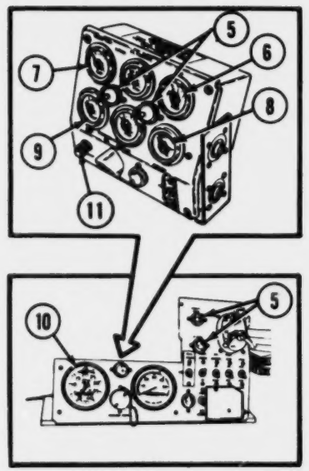


TA472023

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
26		•	INSTRUMENT PANEL - CONT.	D. INSTRUMENT PANEL lights (5) illuminate panel. E. FUEL GAGE (6) should register full when fuel tanks are full. F. WATER TEMP gage (7) should register higher temperature as engine warms up. G. BATTERY generator indicator gage (8) should register battery changing rate. H. TRANSMISSION OIL TEMP gage (9): Registers higher oil temperature as transmission warms up; 220° to 240°F (104° to 115°C) is normal. I. TACHOMETER (10) should register engine speed in rpm. J. LOW COOLANT level indicator (11): Press to test for proper operation.
27		•	STEERING CONTROL	Move steering wheel through its entire range. Observe if steering response is satisfactory. With vehicle operating at 15 to 20 mph (24 to 32 Kmph) and steering wheel centered, observe if the wheel wanders or pulls to one side. Troubleshoot if required (ref. p. 3-25)



TA472024

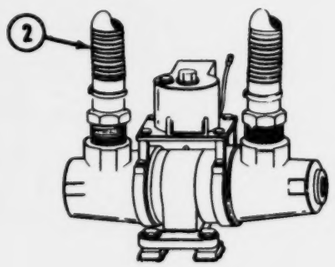
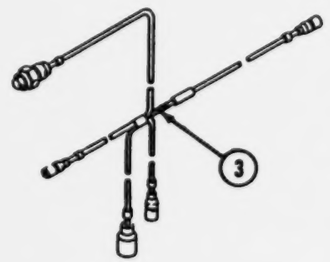
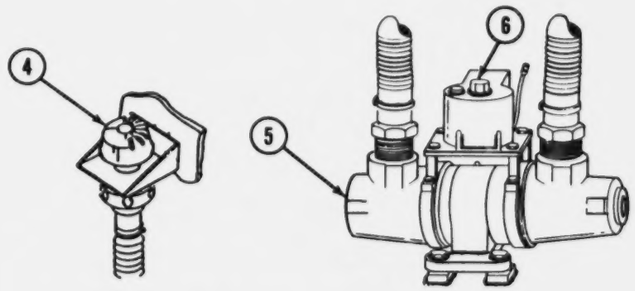
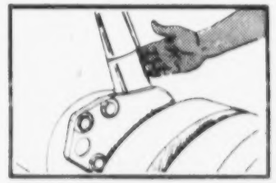
27		•	STEERING CONTROL	Move steering wheel through its entire range. Observe if steering response is satisfactory. With vehicle operating at 15 to 20 mph (24 to 32 Kmph) and steering wheel centered, observe if the wheel wanders or pulls to one side. Troubleshoot if required (ref. p. 3-25).
27.1	•		NBC EQUIPMENT	**WARNING** After suspected NBC exposure of this vehicle, all air filter elements shall be handled only by personnel wearing full NBC protective equipment. A. Inspect M2A2 air purifier (1) for dents, loose connections and missing parts. Replace filters if damaged (ref. p. 11-68). B. Inspect condition of hose assemblies (2). Check for deterioration, loose connections, holes, tears and other damage (ref. p. 11-78). C. Inspect electrical cable assemblies (3) for damaged insulation and broken or damaged terminals.  

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL S	INTERVAL A	ITEM TO BE INSPECTED	PROCEDURES
27.1	•		NBC EQUIPMENT - CONT	D. Operate ventilated face piece system (ref. TM 9-2350-311-10). Check that air moves through each air hose outlet orifice connector (4). **NOTE** Allow M3 heater to operate for approximately 15 minutes before checking for warm air circulation. E. Check operation of M3 heater (5) by turning control knob (6) ON. Indicator light should be lit and air should get warmer as knob is turned clockwise. F. Troubleshoot NBC system if defective (ref. p. 3-109).  G. Test Gas Particulate Filter unit with M39 Air Flow Tester (ref. TM 3-6680-316-10).

	28		•	BRAKES	Accelerate vehicle to 15 mph (24 Kmph). Release accelerator pedal, and apply brakes. Vehicle should stop without pulling to one side. With the vehicle stopped on an incline and with transmission in neutral, depress brake pedal and apply parking brake. Brakes should lock securely and hold vehicle in place. Adjust brakes if required (p. 9-25).
	29		•	ENGINE GOVERNED SPEED AND PERFORMANCE	Test engine for acceleration and power in each gear. While testing in first gear, accelerate with wide open throttle from low speed to top speed. Governed speed under load should not exceed 2350 rpm. Maximum speeds are as follows: 1st 6 mph (9.6 Kmph) 2nd 9 mph (14.5 Kmph) 3rd 24 mph (38.6 Kmph) 4th 35 mph (56.3 Kmph) R1 5 mph (8.0 Kmph) R2 7 mph (11.3 Kmph)
					NOTE Check items 29 and 30 immediately after road test.
	30		•	TEMPERATURE OF HUBS AND SHOCK ABSORBERS	Feel all wheel hubs cautiously. Notice difference in temperature between hubs. An overheated hub indicates a bearing problem. Feel the lower end of the shock absorber. Check for difference in temperature between hull and shock absorber. If shock absorber is operating properly, it will be warmer than the hull.



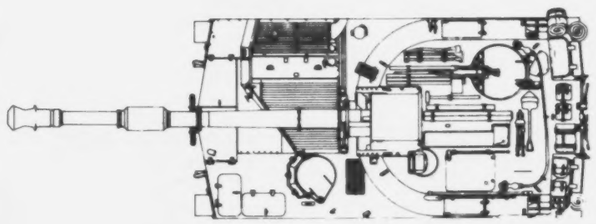
TA472025

TABLE 2-1. ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES

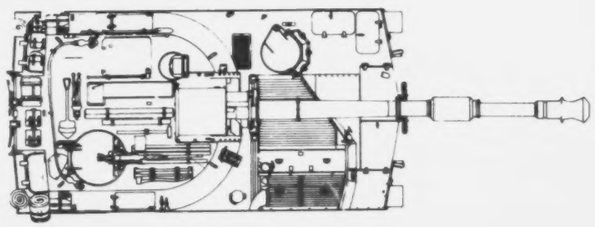
S-SEMIANNUALLY A-ANNUALLY

ITEM	INTERVAL		ITEM TO BE INSPECTED	PROCEDURES
	S	A		
31		•	LEAKAGE FROM POWER PLANT OR CAB HYDRAULIC SYSTEMS	Inspect all areas inside and outside of vehicle for fuel or oil leaks.
32		•	DECALS, INSTRUCTION PLATES, STENCIL MARKINGS AND PAINT	Replace decals and instruction plates. Restencil markings that are not legible. Clean and paint bare or worn spots. Refer to p. 1-35 for stencil locations.
33		•	FINAL ROAD TEST	Check the performance of items that were adjusted, repaired or replaced as a result of the road test.

2-15. PRE-STARTING INSTRUCTIONS



SAFE POSITION



1 Check batteries for damage. Replace damaged batteries (ref. p. 2-6).

2 Check electrolyte level in batteries. Replenish as required (ref. TM 9-2350-311-10).

WARNING

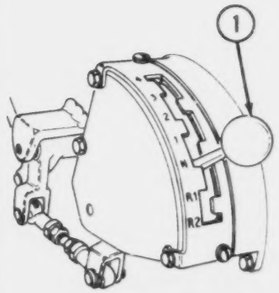
- Do not park vehicles head to head. Personnel injury or damage to the vehicles could occur if one vehicle jumps.
- Do not allow vehicles to touch and leave enough space between vehicles to permit working room for the technician. Shorted circuits could allow electricity to flow through the vehicles causing injury to personnel and/or damage to equipment.

3 Park vehicles in a side-by-side position or park live vehicle in front of and at right angles to the dead vehicle.

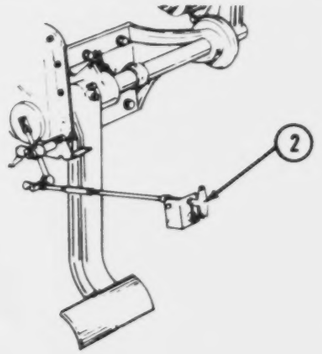
TA472026

GENERAL HULL MAINTENANCE - SECTION V. SLAVE STARTING - CONTINUED

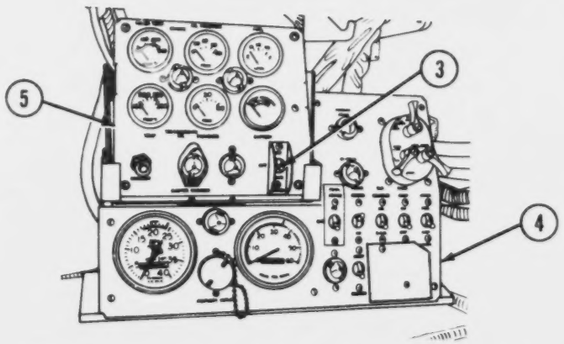
2-15. PRE-STARTING INSTRUCTIONS - CONTINUED



4 Place both vehicles shift levers (1) in N (Neutral) position.



5 Set parking brakes (2) on both vehicles.



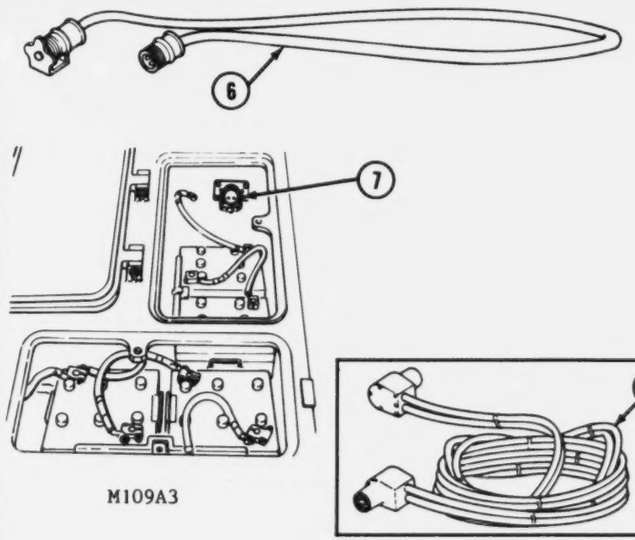
CAUTION

Insure all electrical equipment and all switches are off to prevent damage to the electrical system.

6 Place MASTER switch (3) in OFF position.

7 Place all electrical switches in OFF position in driver's (4) and portable (5) instrument panels.

TA472027

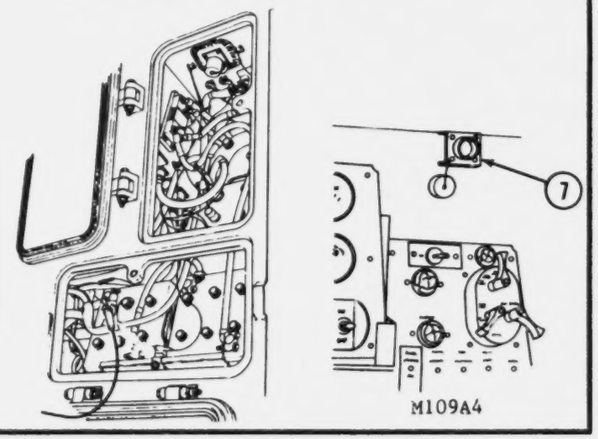


NOTE

Location of slave receptacle differs in M109A2/M109A3 and M109A4 vehicles.

- Nato Slave cables are used on M109A2/M109A4

8 Attach slave cable (6) securely to slave receptacle (7) in both vehicles.



2-16. STARTING INSTRUCTIONS

WARNING

Insure master switches are off on both vehicles after vehicles are fully charged.

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GENERAL HULL MAINTENANCE - SECTION V. SLAVE STARTING - CONTINUED

2-16. STARTING INSTRUCTIONS - CONTINUED

1 For M109A2/M109A3 vehicles only, place MASTER switch to SLAVE position on dead vehicle. Leave switch off for M109A4's.

2 Place MASTER switch to ON in live vehicle and run engine at 1000 to 1200 rpm.

3 Allow batteries in dead vehicle to charge for 5 minutes before trying to start the vehicle.

4 Idle engine of live vehicle and turn off MASTER switch.

5 Refer to TM 9-2350-311-10 for starting procedures. Start up the dead vehicle.

6 After engine is running smoothly, turn off MASTER switch.

TORQUE CHART

If torque requirements are unavailable, use this chart as a guide.

TORQUE VALUE GUIDE (POUND-FEET)				
SCREW DIAMETER	TORQUE LB-FT NO DASHES (SAE GRADE 2)	TORQUE LB-FT 3 DASHES (SAE GRADE 5)	TORQUE LB-FT 6 DASHES (SAE GRADE 8)	SOCKET SIZE
1/4 - 20 UNC	3 - 5	6 - 8	10 - 12	7/16
1/4 - 28 UNF	4 - 6	8 - 10	9 - 14	7/16
5/16 - 18 UNC	7 - 11	13 - 17	19 - 24	1/2
5/16 - 24 UNF	7 - 11	14 - 19	23 - 28	1/2
3/8 - 16 UNC	14 - 18	26 - 31	39 - 44	9/16
3/8 - 24 UNF	15 - 19	30 - 35	46 - 51	9/16
7/16 - 14 UNC	23 - 28	44 - 49	65 - 70	5/8
7/16 - 20 UNF	23 - 28	44 - 54	69 - 79	5/8
1/2 - 13 UNC	32 - 37	65 - 75	95 - 105	3/4
1/2 - 20 UNF	34 - 41	73 - 83	113 - 123	3/4
9/16 - 12 UNC	46 - 56	100 - 110	145 - 155	13/16
9/16 - 18 UNF	47 - 57	107 - 117	165 - 175	13/16
5/8 - 11 UNC	62 - 72	140 - 150	200 - 210	15/16
5/8 - 18 UNF	67 - 77	153 - 163	235 - 245	15/16
3/4 - 10 UNC	106 - 116	200 - 270	365 - 375	1 1/4
3/4 - 16 UNF	115 - 125	268 - 278	417 - 427	1 1/4
7/8 - 9 UNC	165 - 175	385 - 395	595 - 605	1 5/16
7/8 - 14 UNF	178 - 188	424 - 434	663 - 673	1 5/16
1 - 8 UNC	251 - 261	580 - 590	900 - 910	1 1/2
1 - 14 UNF	255 - 265	585 - 634	943 - 993	1 1/2
1 1/4 - 7 UNC	541 - 461	1070 - 1120	1767 - 1817	1 7/8
1 1/4 - 12 UNF	488 - 498	1211 - 1261	1963 - 2013	1 7/8
1 1/2 - 6 UNC	727 - 737	1899 - 1949	3111 - 3161	2 1/4
1 1/2 - 12 UNF	816 - 826	2144 - 2194	3506 - 3556	2 1/4

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TORQUE CHART

If torque requirements are unavailable, use this chart as a guide.

TORQUE VALUE GUIDE (NEWTON-METERS)				
SCREW DIAMETER	TORQUE N·m NO DASHES (SAE GRADE 2)	TORQUE N·m 3 DASHES (SAE GRADE 5)	TORQUE N·m 6 DASHES (SAE GRADE 8)	SOCKET SIZE
1/4 - 20 UNC	4 - 7	8 - 11	14 - 16	7/16
1/4 - 28 UNF	5 - 8	11 - 14	12 - 19	7/16
5/16 - 18 UNC	9 - 15	18 - 23	26 - 33	1/2
5/16 - 24 UNF	9 - 15	19 - 26	31 - 38	1/2
3/8 - 16 UNC	19 - 24	35 - 42	53 - 60	9/16
3/8 - 24 UNF	20 - 26	41 - 47	62 - 69	9/16
7/16 - 14 UNC	31 - 38	60 - 66	88 - 95	5/8
7/16 - 20 UNF	31 - 38	60 - 73	94 - 107	5/8
1/2 - 13 UNC	43 - 50	88 - 102	129 - 142	3/4
1/2 - 20 UNF	46 - 56	99 - 113	153 - 167	3/4
9/16 - 12 UNC	62 - 76	136 - 149	197 - 210	13/16
9/16 - 18 UNF	64 - 77	145 - 159	224 - 237	13/16
5/8 - 11 UNC	84 - 98	190 - 203	271 - 285	15/16
5/8 - 18 UNF	91 - 104	207 - 221	319 - 332	15/16
3/4 - 10 UNC	144 - 157	353 - 366	495 - 508	1 1/4
3/4 - 16 UNF	156 - 169	363 - 377	565 - 579	1 1/4
7/8 - 9 UNC	224 - 237	522 - 536	807 - 820	1 5/16
7/8 - 14 UNF	241 - 255	575 - 588	899 - 912	1 5/16
1 - 8 UNC	340 - 354	786 - 800	1220 - 1234	1 1/2
1 - 14 UNF	346 - 359	793 - 860	1279 - 1346	1 1/2
1 1/4 - 7 UNC	611 - 625	1451 - 1518	2396 - 2463	1 7/8
1 1/4 - 12 UNF	662 - 675	1642 - 1710	2661 - 2729	1 7/8
1 1/2 - 6 UNC	986 - 999	2575 - 2642	4218 - 4286	2 1/4
1 1/2 - 12 UNF	1106 - 1120	2907 - 2975	4753 - 4821	2 1/4

CHAPTER 3
TROUBLESHOOTING

This chapter illustrates and provides specific instructions for troubleshooting the M109A2/M109A3/M109A4 howitzer hull assemblies.

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3-2	QUICK GUIDE TO TROUBLESHOOTING	3-4
3-3	TROUBLESHOOTING CHART	3-11

3-1. GENERAL INSTRUCTIONS TO TROUBLESHOOTING

This chapter contains a "Quick Guide to Troubleshooting" index and a troubleshooting chart. The Quick Guide to Troubleshooting is the master reference table for locating troubleshooting information. The Guide contains a list of various malfunctions which may occur during operation or inspection of the M109A2/M109A3/M109A4 vehicles and provides a reference to the troubleshooting information of the troubleshooting chart or a solution. The troubleshooting chart provides step-by-step instructions for isolating and correcting malfunctions.

STE/ICE or STE/ICE-R TROUBLESHOOTING

When a malfunction is recognized on the engine systems of the M109A2/M109A3/M109A4 vehicles, the Quick Guide may reference Appendix D, a page number and a NO-GO CHAIN. This means there is a STE/ICE (Simplified Test Equipment for Internal Combustion Engine) method for analyzing the malfunction. The STE/ICE method will be the primary troubleshooting procedure when referenced, the back-up procedure should be used only when STE/ICE is unavailable.

ELECTRICAL TROUBLESHOOTING

Electrical troubleshooting in this chapter provides schematic diagrams and pictorial diagrams to give insight to the harnesses involved.

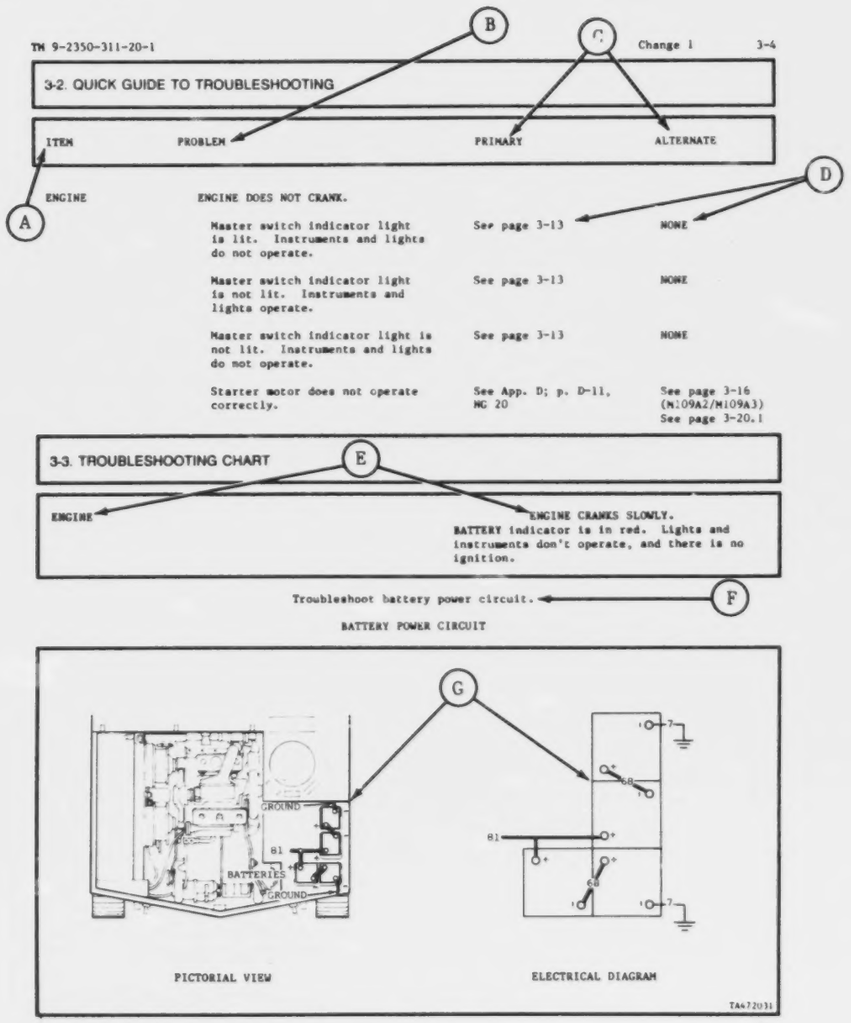
When troubleshooting any electrical system or component, exercise extreme care to prevent electrical shock.

WARNING

Throughout troubleshooting of the electrical system or electrical components be certain MASTER switch is OFF between every step unless otherwise directed. Remove all jewelry and metal objects when working on the electrical systems to prevent injury due to electrical shock.

The multimeter is used throughout troubleshooting. For a quick reference to multimeter operation see page 2-11. STE/ICE can also perform as a multimeter and instruction on its use can be found in TM 9-4910-571-12&P.

To use the Quick Guide to Troubleshooting and the troubleshooting chart, follow the instructions below. If the problem is not listed or corrected, notify support maintenance.



A Find the name of the item that doesn't work.

B Find the problem with the item.

C Find the solution to the problem.

D Turn to the page number referenced in the troubleshooting chart or perform the maintenance procedure described (or provided).

E Recheck the item and problem.

F Follow the steps to fix the item or turn to the page number given.

G Refer to pictorial view and electrical diagram for location of items to be troubleshot. Steps for troubleshooting will follow.

NOTE

Electrical harness views are included in the troubleshooting chart as reference guides only (refer to Chapter 8 for detailed information on the electrical harnesses).

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3-2. QUICK GUIDE TO TROUBLESHOOTING

ITEM	PROBLEM	PRIMARY	ALTERNATE
ENGINE	ENGINE DOES NOT CRANK.		
	Master switch indicator light is lit. Instruments and lights do not operate.	See page 3-13	NONE
	Master switch indicator light is not lit. Instruments and lights operate.	See page 3-13	NONE
	Master switch indicator light is not lit. Instruments and lights do not operate.	See page 3-13	NONE
	Starter motor does not operate correctly.	See App. D; p. D-11, NG 20	See page 3-16 (M109A2/M109A3) See page 3-20.1 (M109A4)
	All electrical accessories operate	See App. D; p. D-11, NG 80	See page 3-16 (M109A2/M109A3) See page 3-20.1 (M109A4)
	COMBAT OVERRIDE SWITCH WILL NOT OVERRIDE (M109A4).	See page 3-20.1	NONE
	ENGINE CRANKS FOR SHORT TIME ONLY (M109A4).	See page 3-20.1	NONE
	ENGINE CRANKS SLOWLY.	See App. D; p. D-11, NG 30	See page 3-11

	ENGINE CRANKS BUT DOES NOT START.	See App. D; p. D-11, NG 30	See page 3-20.8
	ENGINE IDLES OVER 650 RPMS.	Adjust hand throttle control rod and accelerator pedal (ref. p. 9-51 and 9-53).	NONE
	ENGINE DOES NOT ACCELERATE PROPERLY.	See page 3-21	NONE
	ENGINE DOES NOT KEEP STEADY SPEED.	See page 3-21	NONE
	ENGINE DOES NOT DEVELOPE FULL POWER. Engine runs slowly and idles roughly.	See page 3-21	
	ENGINE USES OIL.	See page 3-22	NONE
	ENGINE USES TOO MUCH FUEL.	See page 3-22	NONE
	BLACK EXHAUST SMOKE IS PRESENT.	See page 3-22	NONE
	WHITE EXHAUST SMOKE IS PRESENT.	See page 3-22	NONE
	EXHAUST FUMES ARE PRESENT IN CREW COMPARTMENT.	See page 3-23	NONE
	ENGINE HAS LOW OR NO OIL PRESSURE.	See App. D; p. D-11, NG5	See page 3-23
	ENGINE OVERHEATS.	See page 3-23	NONE
TRANSMISSION AND DRIVING CONTROLS	HAND THROTTLE CONTROL DOESN'T MAIN-CONSTANT SPEED.	Check for loose mounting bolts on hand throttle control rod and accelerator shaft	NONE

3-2. QUICK GUIDE TO TROUBLESHOOTING

ITEM	PROBLEM	PRIMARY	ALTERNATE
TRANSMISSION AND DRIVING CONTROLS (CONT'D)	ENGINE DOESN'T CHANGE RPM WHEN ACCLERATED.	Adjust accelerator pedal and hand throttle control rod (ref. p. 9-51 and 9-53).	NONE
	VEHICLE CREEPS FORWARD IN NEUTRAL.	Adjust transmission shift control linkage (ref. p. 9-19).	NONE
	TRANSMISSION OVERHEATS.		
	TRANSMISSION OIL TEMP gage is over 270 F(132°C). Master warning light is lit.	See page 3-24	NONE
	TRANSMISSION OIL TEMP gage is under 270 F (132°C). Master warning light is lit.	See page 3-24	NONE
	VEHICLE DRIVES, BUT NOT IN SELECTED RANGE.		
	Shift lever is in third gear, transmission is in first gear.	Adjust tansmission shift control linkage (ref. p. 9-19).	NONE
	VEHICLE DOESN'T DRIVE.		
	Transmission doesn't operate in any shift operation.	See page 3-24.	NONE

	SHIFT CONTROL DOESN'T MOVE TO SELECTED RANGE.	Adjust transmission shift control linkage (ref. p. 9-19).	NONE
	VEHICLE DOESN'T STEER IN EITHER DIRECTION IN ANY RANGE.	See page 3-25.	NONE
	VEHICLE STEERS WELL IN ONE DIRECTION ONLY.	See page 3-25.	NONE
TRACKS AND SUSPENSION	VEHICLE BRAKES POORLY.		
	Vehicle doesn't stop correctly when brake is used.	See page 3-25.	NONE
	VEHICLE PULLS TO ONE SIDE WITH STEERING WHEEL IN CENTER POSITION.	See page 3-26	NONE
	VEHICLE THROWS TRACKS.	See page 3-26	NONE
	VEHICLE SAGS TO ONE SIDE.	Check for correct installation of torsion bars (ref. p. 10-20).	NONE
	SUSPENSION SYSTEM IS NOISY DURING OPERATION.	See page 3-26.	NONE
FLAME HEATER	FLAME HEATER DOESN'T OPERATE.	See page 3-27	NONE
	Motor and pump assembly doesn't operate.	See page 3-27	NONE
	Fuel solenoid doesn't operate.	See page 3-27	NONE
	Fuel prime pump doesn't operate.	See page 3-27	NONE
	Ignition unit doesn't operate.	See page 3-27	NONE

3-2. QUICK GUIDE TO TROUBLESHOOTING

ITEM	PROBLEM	PRIMARY	ALTERNATE
ENGINE MASTER WARNING LIGHT (ON STEERING SHAFT)	STEERING SHAFT MASTER WARNING LIGHT DOESN'T LIGHT.	See page 3-33	NONE
	STEERING SHAFT MASTER WARNING LIGHT DOESN'T LIGHT WHEN PRESS-TO-TEST IS PERFORMED.	See page 3-33	NONE
ENGINE MASTER WARNING LIGHT (ON PORTABLE INSTRUMENT PANEL)	MASTER WARNING LIGHT DOESN'T LIGHT.		
	MASTER switch is on and engine is off, warning light isn't lit.	See page 3-35	NONE
	MASTER WARNING LIGHT IS LIT.		
	Everything appears normal, but master warning light is lit.	See page 3-35	NONE
AIR CLEANER BLOWER MOTOR	MOTOR DOESN'T OPERATE.		
	Engine is running, but blower motor doesn't operate.	See page 3-38 (M109A2/M109A3)	NONE
	Vehicle is in drive but blower motors don't operate.	See page 3-42.1 (M109A4)	NONE
	MOTOR DOESN'T STOP.		
	Engine is off and MASTER switch is on, and motor runs.	See page 3-38 (M109A2/M109A3)	NONE

	Vehicle is in neutral and MASTER switch is on, and motors run.	See page 3-42.1 (M109A4)	NONE
	ONE BLOWER MOTOR DOESN'T OPERATE.	See page 3-38 (M109A2/M109A3) See page 3-42.1 (M109A4)	NONE
ALTERNATOR	CHARGING SYSTEM DOESN'T OPERATE. Gage shows not charging with engine running or isn't steady or accurate.	See page 3-43 (M109A2) or 3-51 (M109A3) or 3-58 (M109A4)	NONE
	BATTERY IS OVERCHARGING.		
	BATTERY gage is in bright red.	See page 3-43 or 3-51 or 3-58	NONE
GAGES	ENGINE COOLANT TEMPERATURE GAGE NEEDLE DOESN'T MOVE OR ISN'T STEADY OR ACCURATE.	See page 3-58.8	See App. D; p. D-11, NG 31
	ENGINE LOW LEVEL COOLANT LIGHT DOESN'T LIGHT OR GIVES FALSE INDICATION OF COOLANT LOW LEVEL CONDITIONS.	See page 3-58.8	See App. D; P. D-11, NG 31
	TRANSMISSION OIL TEMPERATURE GAGE NEEDLE DOESN'T MOVE OR ISN'T STEADY OR ACCURATE.	See page 3-63	See App. D; p. D-11, NG 31
	TRANSMISSION OIL PRESSURE GAGE NEEDLE DOESN'T MOVE OR ISN'T STEADY OR ACCURATE.	See page 3-65	See App. D; p. D-11, NG 31
	BATTERY GAGE NEEDLE DOESN'T MOVE OR ISN'T STEADY OR ACCURATE.		See App. D; P. D-11, NG 31
	FUEL LEVEL GAGE NEEDLE DOESN'T MOVE.	See page 3-67	See App. D; p. D-11, NG 31
	FUEL LEVEL GAGE SHOWS LEVEL FOR LOWER TANK BUT NOT FOR UPPER TANK.	See page 3-67	See App. D; p. D-11, NG 31

3-2. QUICK GUIDE TO TROUBLESHOOTING

ITEM	PROBLEM	PRIMARY	ALTERNATE
GAGES CONT'D	FUEL LEVEL GAGE SHOWS LEVEL FOR UPPER TANK BUT NOT FOR LOWER TANK.	See page 3-67	See App. D; p. D-11, NG 31
DOME LIGHTS	DOME LIGHT IS OUT.	See page 3-70	NONE
SERVICE HEADLIGHTS, TAILLIGHTS, AND STOPLIGHTS	ALL LIGHTS ARE OUT.	See page 3-73	NONE
	HEADLIGHTS ARE OUT.	See page 3-73	NONE
	ONE BEAM ONLY ON HEADLIGHT OPERATES.	See page 3-73	NONE
	RIGHT OR LEFT HEADLIGHT IS OUT.	See page 3-73	NONE
	TAILLIGHT IS OUT.	See page 3-73	NONE
	STOPLIGHT IS OUT.	See page 3-73	NONE
BLACKOUT MARKERS AND BLACKOUT DRIVE LIGHTS	BLACKOUT MARKER LIGHTS ARE OUT.	See page 3-73	NONE
	FRONT BLACKOUT MARKERS ARE OUT.	See page 3-79	NONE
	RIGHT OR LEFT FRONT BLACKOUT MARKER IS OUT.	See page 3-79	NONE
	REAR BLACKOUT MARKERS ARE OUT.	See page 3-79	NONE
	RIGHT OR LEFT REAR BLACKOUT MARKER IS OUT.	See page 3-79	NONE
	BLACKOUT DRIVE LIGHT IS OUT.	See page 3-79	NONE

SERVICE BLACKOUT INFRARED HEAD-LIGHTS	BOTH BEAMS DON'T OPERATE.	See page 3-83	NONE
	ONE BEAM DOESN'T OPERATE.	See page 3-83	NONE
	BLACKOUT STOPLIGHT IS OUT.	See page 3-83	NONE
INSTRUMENT PANEL LIGHTS	ONE OR MORE LIGHTS ARE OUT.	See page 3-87	NONE
	ALL LIGHTS ARE OUT.	See page 3-87	
	LIGHTS ARE OUT ON BRIGHT OR DIM.	Replace dimmer switch (ref. p. 8-66).	NONE
PERSONNEL HEATER	PERSONNEL HEATER DOESN'T OPERATE.	See page 3-89	NONE
	HEATER WILL NOT STOP WHEN SWITCH IS OFF.	Notify Direct Support maintenance	NONE
PERSONNEL VENTI-LATION BLOWER	PERSONNEL VENTILATION BLOWER DOESN'T OPERATE.	See page 3-93	NONE
	AIR CIRCULATION ISN'T SUFFICIENT.	See page 3-97	NONE
BILGE PUMP	BILGE PUMP DOESN'T OPERATE.	See page 3-98	NONE
WINTERIZATION KIT	COOLANT HEATER DOESN'T OPERATE.	See page 3-106.8	NONE
	HEATER BLOWER OPERATES, BUT MOTOR DOESN'T OPERATE.	See page 3-106.8	NONE
	HEATER MOTOR OVERHEATS.	See page 3-106.8	NONE
PARKING BRAKE	PARKING BRAKE WARNING LIGHT IS OUT.	See page 3-102	NONE
ELECTRIC FUEL PUMP	ENGINE MISSES WHEN LOW ON FUEL. ONE OR BOTH FUEL PUMPS ARE NOT OPERATING.	See page 3-104 (M109A2/M109A3) See page 3-106.1 (M109A4)	NONE

3-2. QUICK GUIDE TO TROUBLESHOOTING

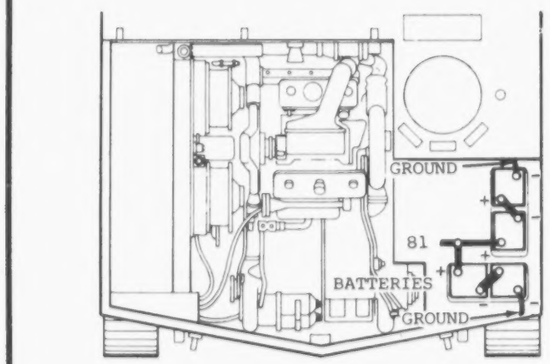
ITEM	PROBLEM	PRIMARY	ALTERNATE
VENTILATED FACE PIECE SYSTEM (M109A4)	NBC INDICATOR LIGHT DOES NCT ILLUMINATE.	See page 3-109	NONE
	AIR PURIFIER, DRIVER'S AND LOADER'S HEATERS DON'T OPERATE.	See page 3-109	NONE
	PURIFIER DOES NOT OPERATE.	See page 3-109	NONE
	DRIVER'S HEATER DOES NOT OPERATE.	See page 3-109	NONE
	CANNONEER NO. 2'S HEATER DOES NOT OPERATE	See page 3-109	NONE
SLAVE START EXTERNAL	SLAVE START DOESN'T OPERATE	See page 3-113	NONE
SLAVE START/EXTERNAL POWER RECEPTACLE (M109A4)	EXTERNAL POWER RECEPTACLE DOESN'T OPERATE.	See page 3-113	NONE

3-3. TROUBLESHOOTING CHART

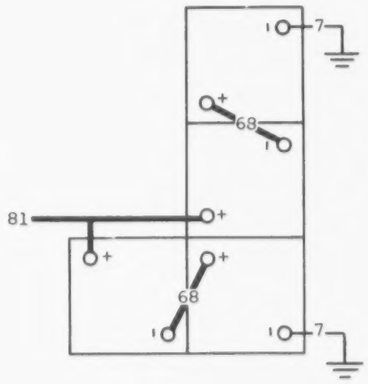
ENGINE	ENGINE CRANKS SLOWLY. BATTERY indicator is in red. Lights and instruments don't operate, and there is no ignition.

Troubleshoot battery power circuit.

BATTERY POWER CIRCUIT



PICTORIAL VIEW

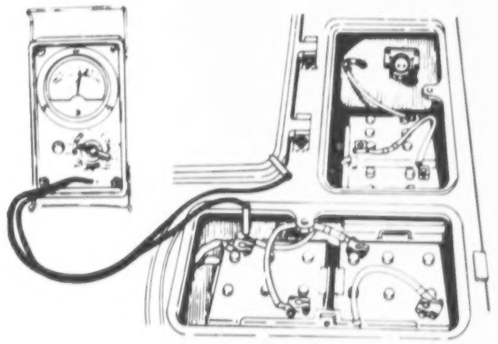


ELECTRICAL DIAGRAM

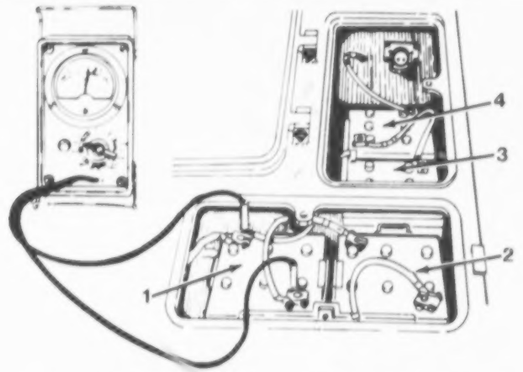
TA472031

NOTE

When using multimeter, refer to chapter 2 for set-up of multimeter.



A Turn MASTER switch ON. Place red multimeter lead on positive post and black lead to ground. Crank engine and check voltage. If voltage is below 18 volts while cranking, clean, tighten, repair, or replace necessary cables and charge batteries. Crank engine and check voltage. If voltage is still below 18 volts, go to step B.



B Turn MASTER switch ON. Place red multimeter lead on positive post and black lead on negative post of battery 1. Crank engine and check voltage; voltage reading should not be below 9 volts. Repeat on batteries 2, 3, and 4. Check all batteries that register below 9 volts (ref. p. 8-56). If battery still registers below 9 volts, replace battery.

TA472032

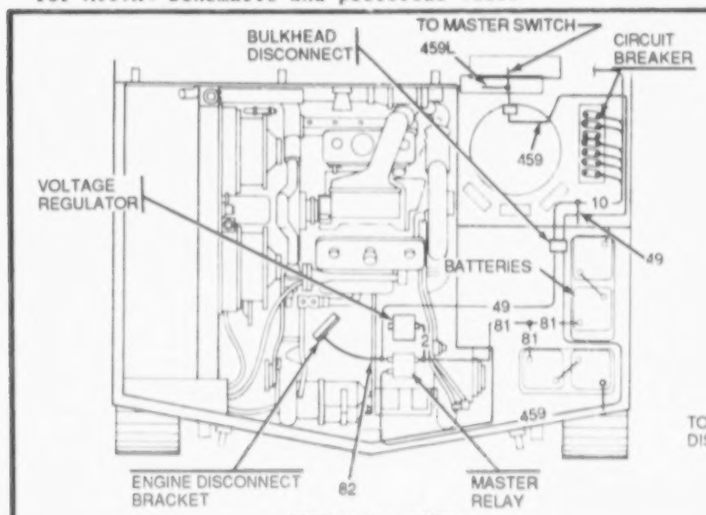
ENGINE	ENGINE DOESN'T CRANK.
	MASTER switch indicator light is lit. Instruments and lights don't operate. Do steps A through D.
	MASTER switch indicator light isn't lit. Instruments and lights don't operate. Do step C.
	MASTER switch indicator light isn't lit. Instruments and lights operate. Do step E.

NOTE

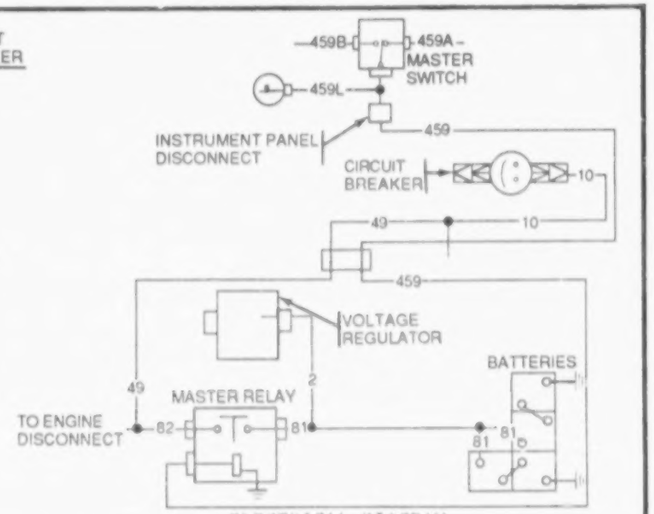
Although the master relay circuit differs slightly between M109A2/M109A3 and M109A4 vehicles, the following troubleshooting procedure applies to either. Refer to page 3-14 for M109A4 schematic and pictorial view.

Troubleshoot master relay circuit.

MASTER RELAY CIRCUIT
M109A2/M109A3

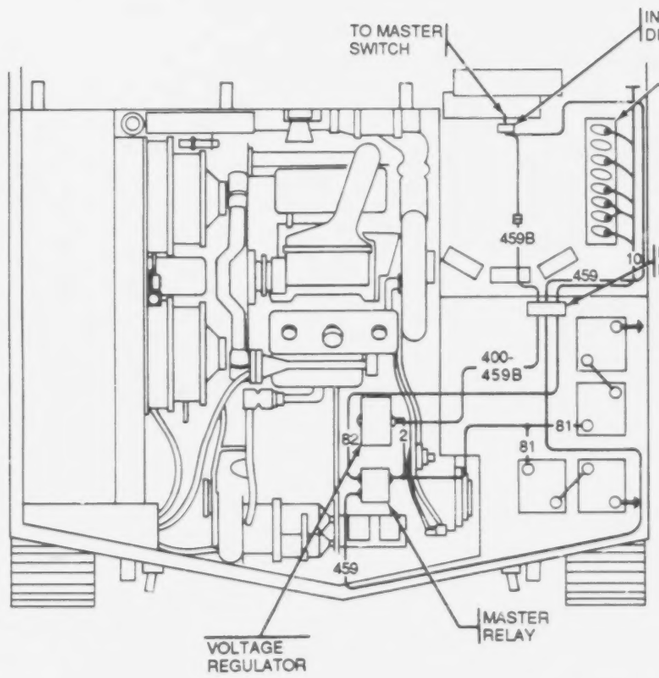


PICTORIAL VIEW

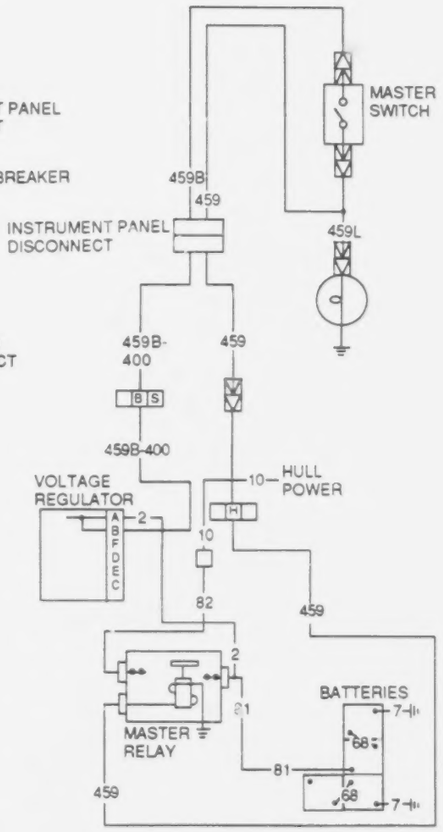


ELECTRICAL DIAGRAM

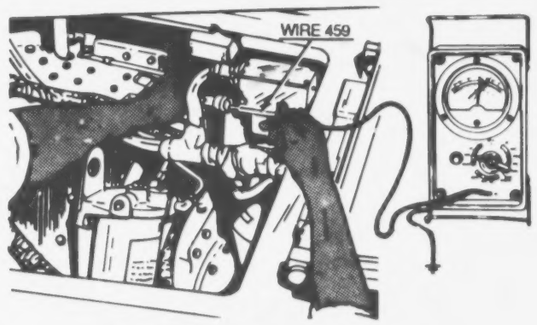
M109A4 MASTER RELAY CIRCUIT



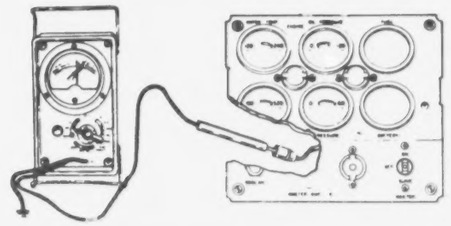
PICTORIAL VIEW



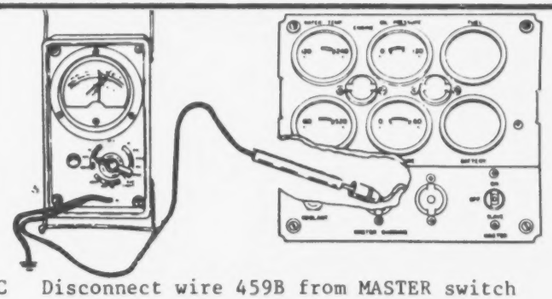
ELECTRICAL DIAGRAM



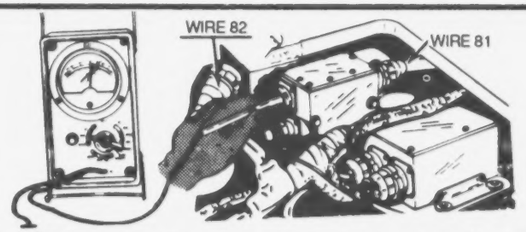
A Disconnect wire 459 from master relay. Turn MASTER switch ON. Place red lead of multimeter in wire 459 and ground black lead. Check for voltage. If no voltage, go to step B. If voltage is present, go to step D.



B Disconnect wire 459 from MASTER switch (center plug on back of switch; M109A2/M109A3). Place red multimeter lead in switch and black lead to ground. With MASTER switch turned ON, check for voltage. If voltage is present, repair or replace wire 459 from MASTER switch to master relay (ref. P. 8-106.4). If no voltage, go to step C.



C Disconnect wire 459B from MASTER switch (bottom plug). 459B is a hot wire. Place red multimeter lead in wire 459B, ground black lead, and check for voltage. If voltage is present, replace MASTER switch (ref. p. 8-22). If no voltage, repair or replace wire 459B-400 (ref. p. 8-106.4).



D Reconnect all wires and check wire 81 for breaks, cuts, and corroded terminals. Replace if necessary. Disconnect wire 82 from master relay. Turn MASTER switch ON. Place red multimeter lead in master relay and ground black lead. Check voltage. If no voltage, replace master relay (ref. p. 8-58). If voltage is present, repair or replace wire 82 (ref. p. 8-139;M109A2/M109A3) or (ref. p. 8-140.1;M109A4).

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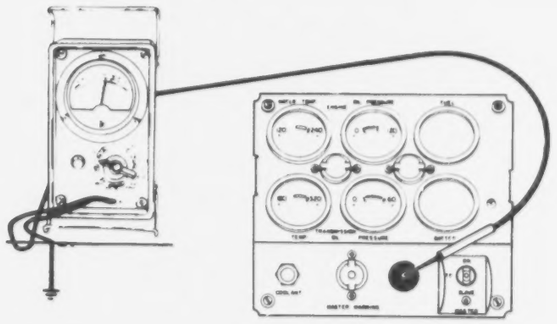


E Remove MASTER switch indicator light from socket. Turn MASTER switch ON. Place red multimeter lead in center of socket and black lead to ground. Check for voltage. If voltage is present, replace light bulb. If no voltage, repair or replace wire 459L (ref. p.8-106.4).

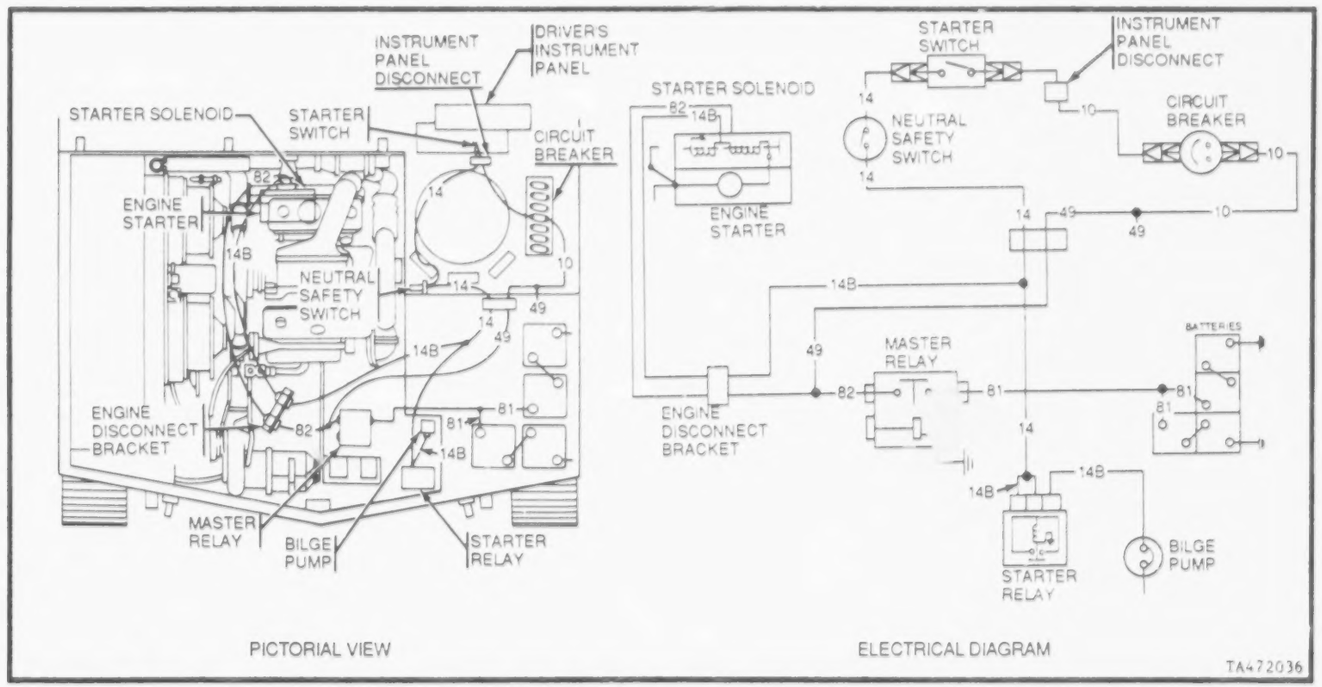
ENGINE (M109A2/M109A3)	ENGINE DOESN'T CRANK. All electrical accessories operate.

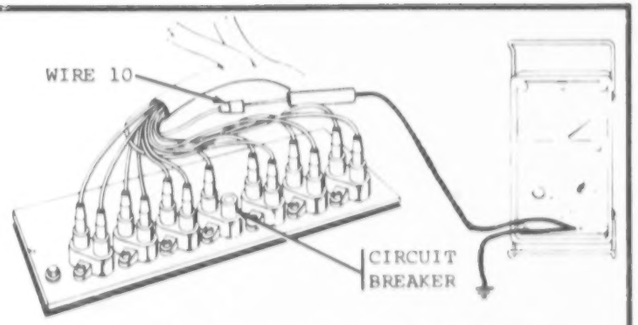
Troubleshoot starter motor circuit.

NOTE

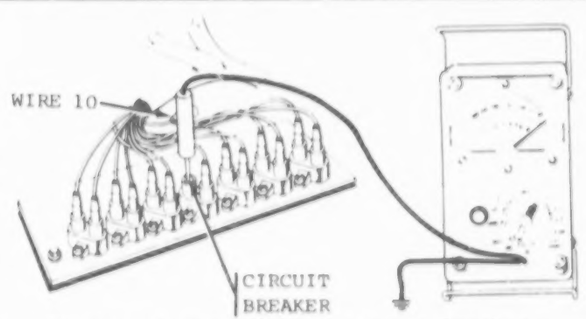
Ensure the shift lever is in the neutral position before troubleshooting this circuit.

M109A2/M109A3 STARTER MOTOR CIRCUIT

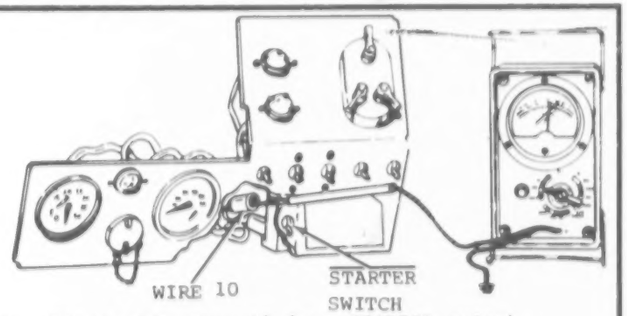




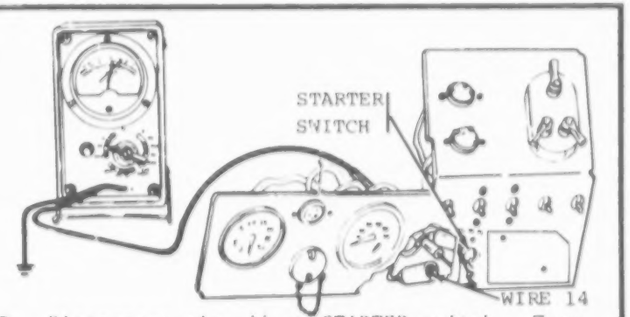
A Disconnect wire 10 from circuit breaker input. Turn MASTER switch ON. Place red lead of multimeter in connector and black lead to ground. Check for voltage. If voltage is present, go to step B. If no voltage, repair or replace wire 10 of input circuit (ref. p. 8-100 or 8-103).



B Disconnect wire 10 from circuit breaker output. Turn MASTER switch ON. Using multimeter, place red lead in circuit breaker output and black to ground. Check for voltage. If voltage is present, go to step C. If no voltage, replace circuit breaker (ref. p. 8-62).

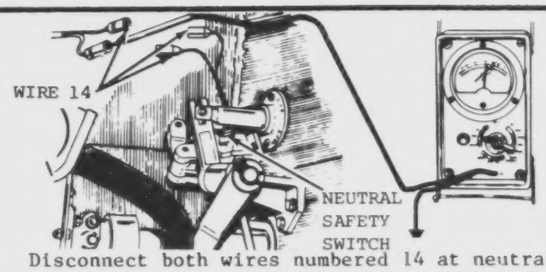


C Disconnect wire 10 from STARTER switch. Turn MASTER switch ON. Using multimeter, place red lead in wire 10. Ground black lead. Check for voltage. If voltage is present, go to step D. If no voltage, replace wire 10 from STARTER switch to circuit breaker.

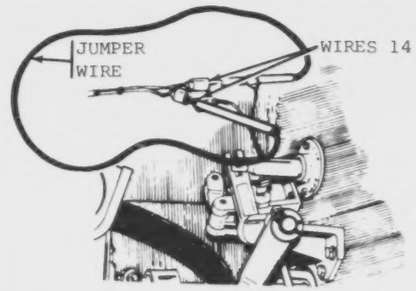


D Disconnect wire 14 at STARTER switch. Turn MASTER switch ON. Using multimeter, place red lead in STARTER switch output and black lead to ground. Push STARTER switch to check for voltage. If voltage is present, go to step E. If voltage is not present, replace STARTER switch (ref. p. 8-22).

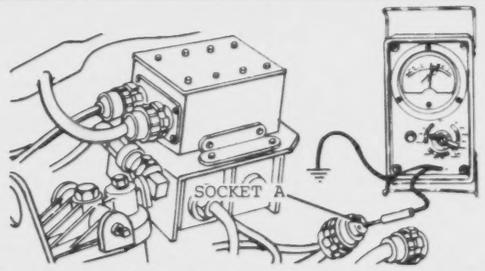
TA472037



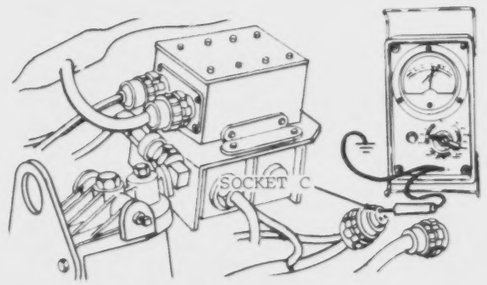
E Disconnect both wires numbered 14 at neutral safety switch. Turn MASTER switch ON. Place red multimeter lead in cable end of connector and black multimeter lead to ground. Push STARTER switch and check for voltage in each wire. If voltage is present in either wire, go to step F. If no voltage, repair or replace wire 14 from neutral safety switch to STARTER switch.



F Using jumper wire, connect wires 14 together. Turn MASTER switch ON and push STARTER switch. If engine cranks, adjust or replace neutral safety switch (ref. p. 8-18). Reconnect all wires. If engine doesn't crank, go to step G.



G Disconnect electrical connector at starter relay. Turn MASTER switch ON. Using multimeter, place red lead in socket A and ground black lead. Place shift lever in neutral. Push STARTER switch and observe voltage. If no voltage is present, repair or replace wire 14 from starter relay to neutral safety switch. If voltage is present, go to step H.



H Turn MASTER switch ON. Place red multimeter lead in socket C and ground black lead. Check for voltage. If no voltage, repair or replace wire 14 from starter relay to bilge pump circuit breaker (ref. p. 8-74). If voltage is present, go to step I.

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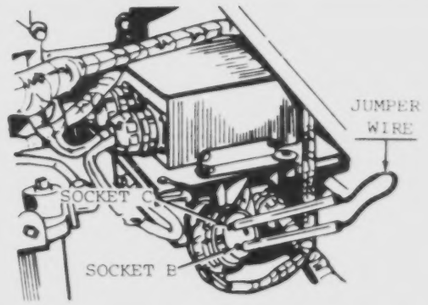
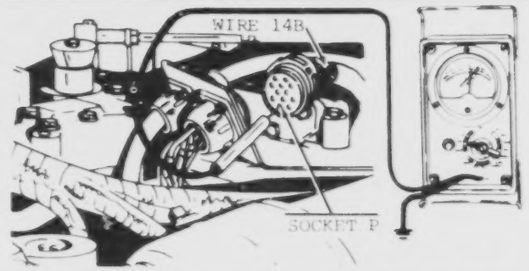
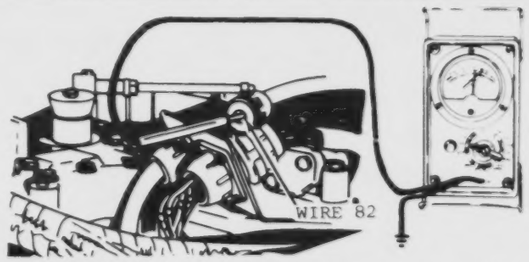


I With starter relay connector still disconnected and MASTER switch ON, use jumper wire between socket C and socket B. If engine cranks, replace starter relay. If engine fails to crank, reconnect relay connector and go to step J.



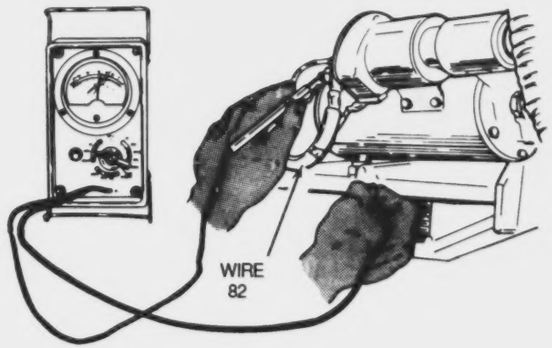
J To check wire 14B, open connector at engine disconnect bracket. Turn MASTER switch ON. Using multimeter, place red lead in socket P and black lead to ground. Push STARTER switch and check for voltage. If no voltage, repair or replace wire 14B from engine disconnect bracket to starter relay (ref. p. 8-74). If voltage is present, reconnect wire 14B and go to step K.



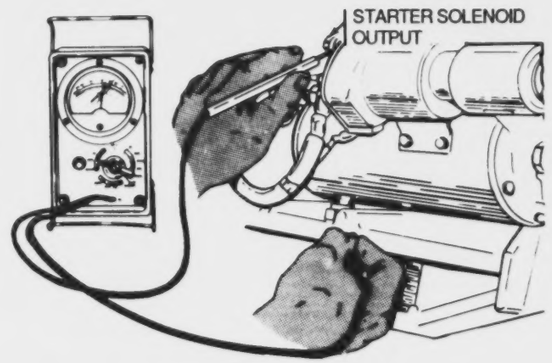
K To check wire 82, open connector at engine disconnect bracket. Turn MASTER switch ON. Place red multimeter lead in connector socket for wire 82 and black lead to ground. Check for voltage. If no voltage, repair or replace wire 82 from engine disconnect bracket to master relay (ref. p. 8-139). If voltage is present, go to step L.

L Remove powerplant from vehicle (ref. p. 4-1). Connect special equipment for operation of powerplant out of vehicle (ref. p. 4-24). Place red multimeter lead on wire 14B at starter solenoid. Ground black wire. Place shift lever in neutral, push STARTER switch, and check for voltage at wire 14B. If no voltage, repair or replace wire 14B from engine disconnect bracket to starter solenoid (ref. p. 8-70). If voltage is present, go to step M.

TA472039



M Turn MASTER switch ON. Place red multimeter lead on wire 82 at starter solenoid and black lead to ground. Check for voltage at starter solenoid. If no voltage, repair or replace wire 82 from starter solenoid to engine disconnect bracket (ref. p. 8-70). If voltage is present, go to step N.



N Turn MASTER switch ON. Place red multimeter lead on starter solenoid output and black lead to ground. Place shift lever in neutral and close STARTER switch. Check for voltage. If voltage is present and engine doesn't crank replace starter. If voltage is not present, replace starter.

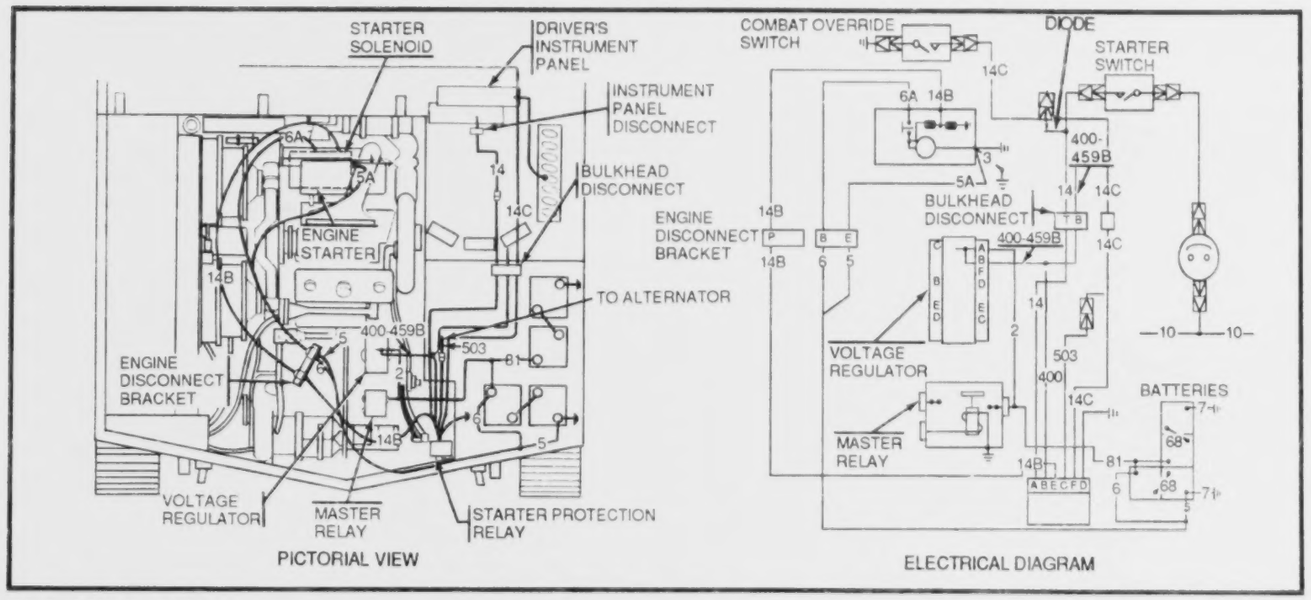
ENGINE (M109A4)	ENGINE DOESN'T CRANK. All electrical accessories operate. Do steps A through R. COMBAT OVERRIDE SWITCH WILL NOT OVERRIDE. Do steps S through V. ENGINE CRANKS FOR SHORT TIME ONLY. Battery power level is correct. Do steps W and X.

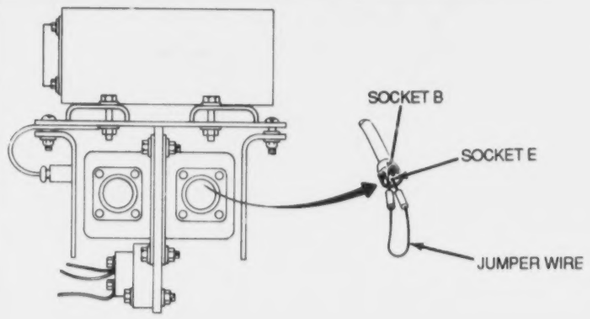
Troubleshoot starter motor circuit.

NOTE

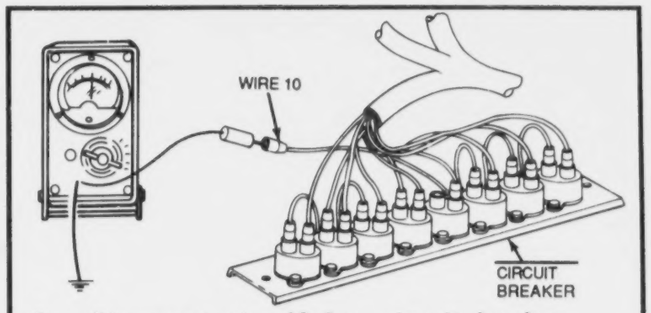
Ensure the shift lever is in the neutral position before troubleshooting this circuit

M109A4 STARTER MOTOR CIRCUIT

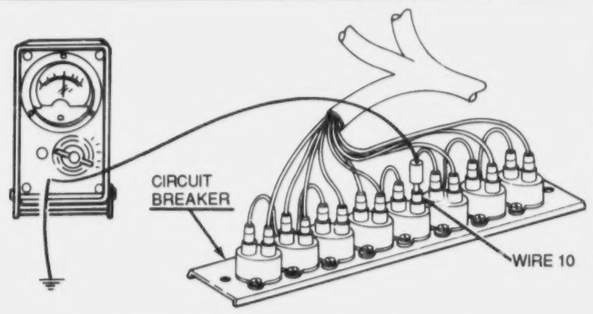




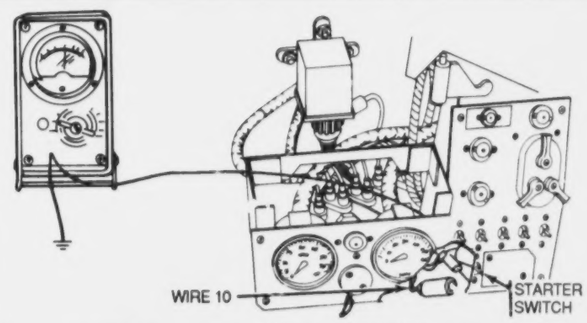
A Disconnect stater protection relay connector. With MASTER switch ON, use jumper wire between socket B and socket E. If engine cranks replace starter protection relay. If engine does not crank, go to step K.



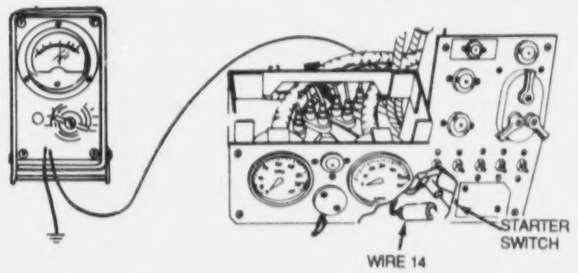
B Disconnect wire 10 from circuit breaker input. Turn MASTER switch ON. Place red lead of multimeter in connector and black lead to ground. Check for voltage. If voltage is not present, repair or replace wire 10 of input circuit (ref. p. 8-106). If voltage is present, go to step C.



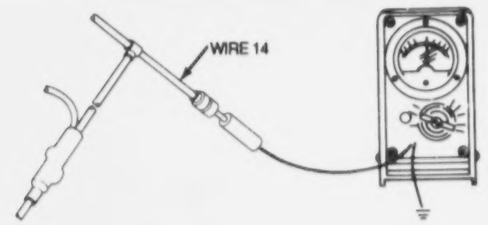
C Disconnect wire 10 from circuit breaker output. Turn MASTER switch ON. Using multimeter, place red lead in circuit breaker output and black to ground. Check for voltage. If voltage is present, go to step D. If no voltage, replace circuit breaker (ref. p. 8-64).



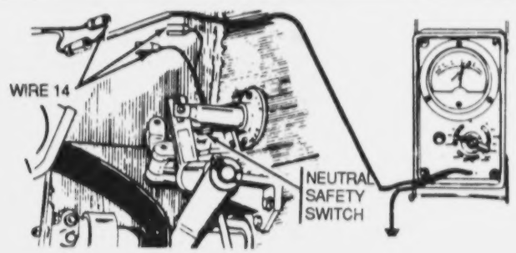
D Disconnect wire 10 from STARTER switch. Turn MASTER switch ON. Using multimeter, place red lead in wire 10. Ground black lead. Check for voltage. If voltage is present, go to step E. If no voltage, replace wire 10 from STARTER switch to circuit breaker (ref. p. 8-90).



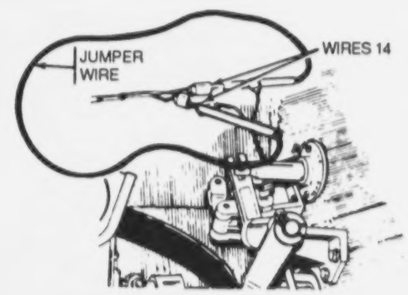
E Disconnect wire 14 at STARTER switch. Turn MASTER switch ON. Using multimeter, place red lead in STARTER switch output and black lead to ground. Push STARTER switch to check for voltage. If voltage is present, go to step F. If voltage is not present, replace STARTER switch (ref. p. 8-26).



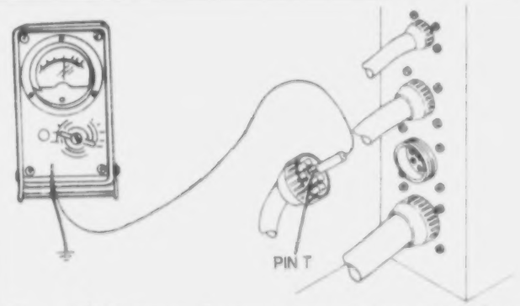
F Disconnect wire 14 at diode harness assembly. With MASTER switch on, place red multimeter lead in connector from STARTER switch and black lead to ground. Push STARTER switch and check for voltage. If voltage is present, go to step G. If voltage is not present, repair or replace diode harness assembly (ref. p. 8-116.2).



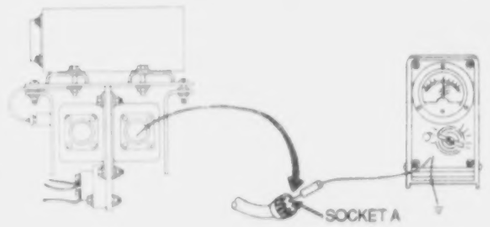
G Disconnect both wires numbered 14 at neutral safety switch. Turn MASTER switch ON. Place red multimeter lead in cable end of connector and black multimeter lead to ground. Push STARTER switch and check for voltage in each wire. If voltage is present in either wire, go to step H. If no voltage, repair or replace wire 14 from neutral safety switch to STARTER switch.



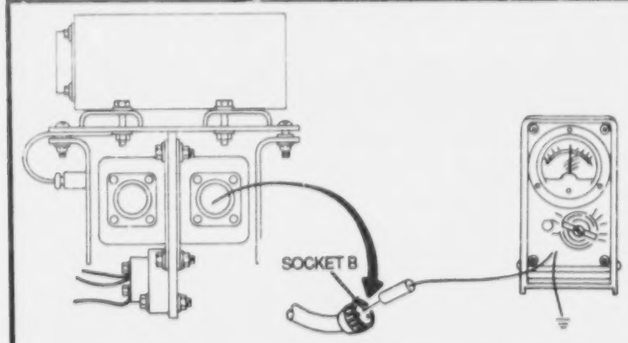
H Using jumper wire, connect wires 14 together. Turn MASTER switch ON and push STARTER switch. If engine cranks, replace neutral safety switch (ref. p. 8-18). Reconnect all wires. If engine doesn't crank, go to step I.



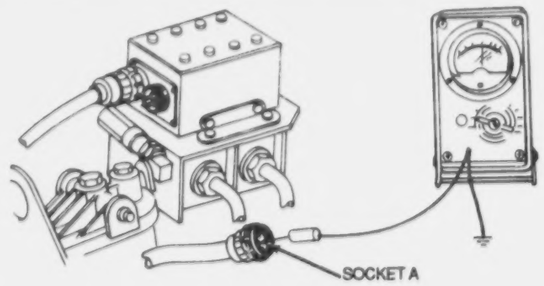
I Disconnect harness connector at driver's bulkhead. Place red multimeter lead in pin T and black to ground. Push STARTER switch to check for continuity. If continuity is present, go to step J. If continuity is not present, repair or replace wire 14 from neutral safety switch (ref. p. 8-84).



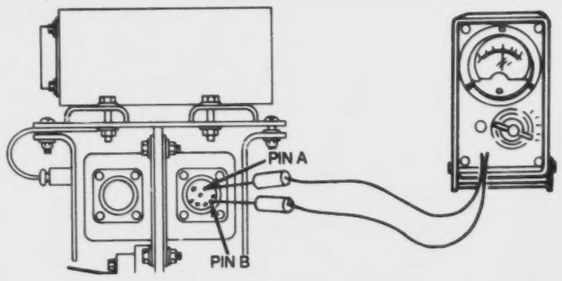
J Disconnect electrical connector at starter protection relay. Turn MASTER switch ON. Using multimeter, place red lead in socket A and ground black lead. Place shift lever in neutral. Push STARTER switch and observe voltage. If no voltage is present, repair or replace wire 14 from starter protection relay to driver's bulkhead (ref. p. 8-76.1). If voltage is present, replace starter protection relay (ref. P. 8-60).



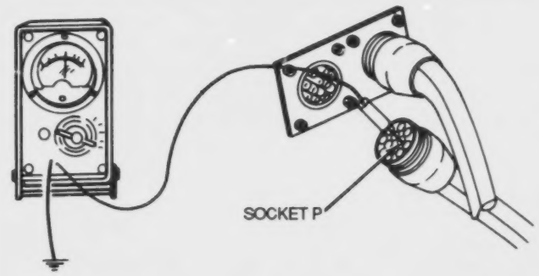
K Disconnect connector at starter protection relay. Place red multimeter lead in socket B and ground black lead. Check for voltage. If no voltage, go to step L. If voltage is present, go to step N.



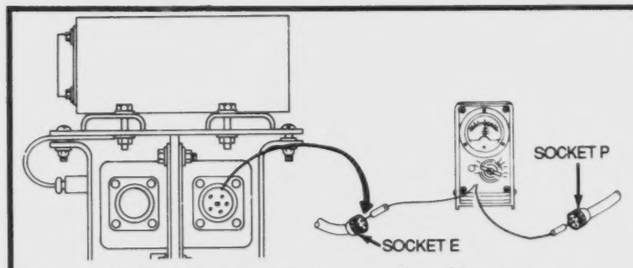
L Disconnect connector at voltage regulator. Place red multimeter in socket A and ground black lead. Check for voltage. If no voltage, repair or replace wire 81 to batteries (ref. p. 8-76.1). If voltage is present, go to step M.



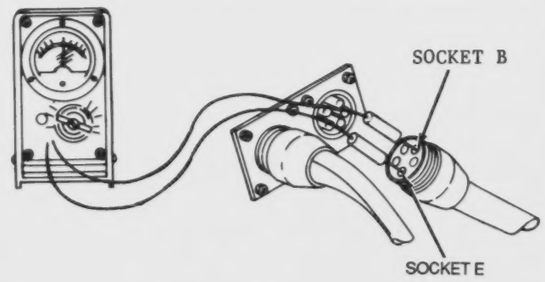
M Disconnect connector at voltage regulator. Place one multimeter lead on pin A and one multimeter lead on pin B. Test for continuity. If circuit is open, replace voltage regulator (ref pg. 8-7). If continuity is present, repair or replace wire 400-459B to starter protection relay. (ref p. 8-76.1)



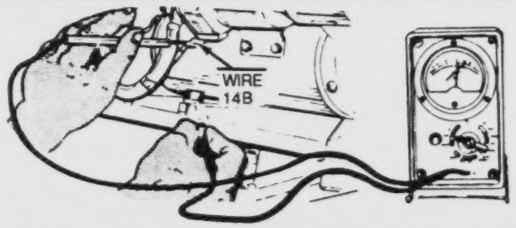
N Disconnect connector at engine disconnect bracket. With MASTER switch ON, place red multimeter lead in socket P. Put black lead to ground. Push STARTER switch and check for voltage. If voltage is not present, go to step O. If voltage is present, go to step P.



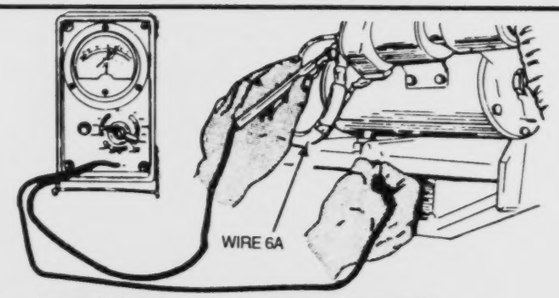
O Disconnect harness at engine disconnect bracket and starter protection relay. Place one multimeter lead in socket P at bracket end and one multimeter lead in socket E at relay end of harness. Check lead for continuity. If lead is open, replace or repair (ref p. 8-76.1). If continuity is present, replace starter protection relay (ref. p. 8-60).



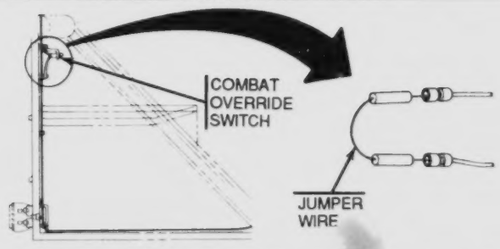
P Disconnect harness at engine disconnect bracket. Place red multimeter lead in socket B and black lead in socket E. Check for voltage. If voltage is present, go to step Q. If voltage is not present, repair or replace harness (ref. p. 8-148).



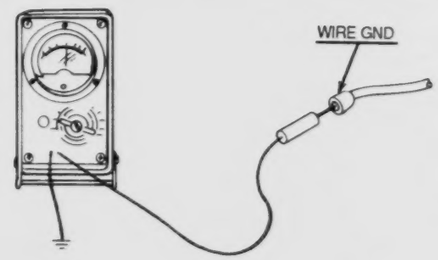
Q Remove powerplant from vehicle (ref. p. 4-1). Connect special equipment for operation of powerplant out of vehicle (ref. p. 4-24). Place red multimeter lead on wire 14B at starter solenoid. Ground black wire. Place shift lever in neutral, push STARTER switch, and check for voltage at wire 14B. If no voltage, repair or replace wire 14B from engine disconnect bracket to starter solenoid (ref. p. 8-74). If voltage is present, go to step R.



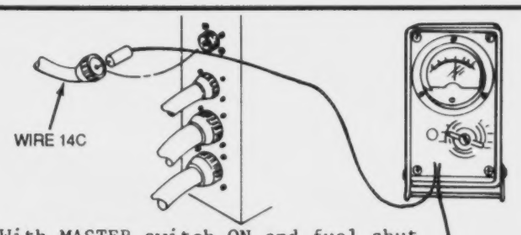
R Turn MASTER switch ON. Place red multimeter lead on wire 6A at starter solenoid and black lead to ground terminal (wire 5A). Check for voltage at starter solenoid. If no voltage, repair or replace wire 6A from starter solenoid to engine disconnect bracket (ref. p. 8-142). If voltage is present, replace engine starter motor (ref. p. 8-17).



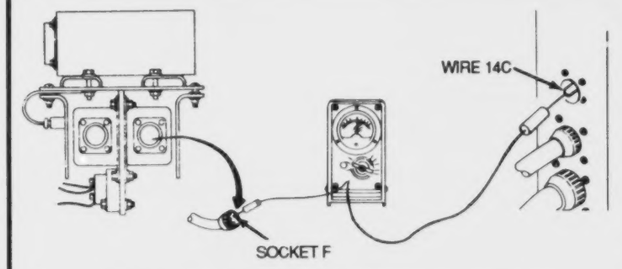
S With MASTER switch ON and fuel shut off handle pulled out, crank engine starter until it automatically shuts off. Disconnect both wires (14C and GND) at combat override switch. Using jumper wire connect wires 14C and GND. Attempt to start engine. If starter cranks replace combat override switch (ref. p. 8-68.3). If starter does not crank go to step T.



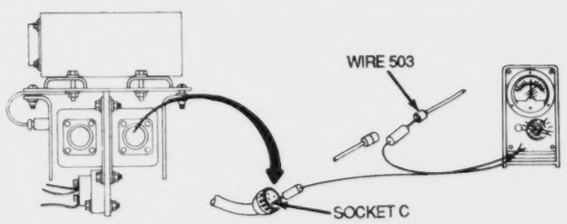
T Disconnect wire GND at combat override switch. Place red multimeter lead in socket wire GND and black to ground. Check for continuity. If lead has continuity go to step U. If lead is open replace wire GND.



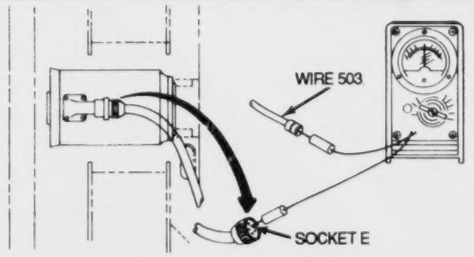
U With MASTER switch ON and fuel shut off handle pulled out, crank engine start until it automatically shuts off. Disconnect connector at driver's bulkhead and turn combat override switch ON. Place red multimeter lead in socket of connector (wire 14C) and black to ground. Check for continuity. If continuity is present do not connect bulkhead connector and go to step V. If lead is open repair or replace wire 14C to combat override switch (ref. p. 8-150).



V Disconnect harness connector at starter protection relay. Place one lead of multimeter in socket F at relay and one lead on pin (wire 14C) at bulkhead. Test for continuity. If continuity is present replace starter protection relay (ref. p. 8-60). If lead is open, repair or replace wire 14C from relay to bulkhead connector (ref. p. 8-76.1).



W Disconnect harness at starter protection relay and connector, wire 503. Place one lead of multimeter in connector and one lead in socket C at relay. Check for continuity. If lead has continuity reconnect harness connector only at starter protection relay and go to step X. If continuity is not measured repair or replace harness (ref. p. 8-76.1).



X Disconnect harness connector at alternator. Place on lead of multimeter in socket E of connector at alternator and one lead in connector, wire 503. Check for continuity. If continuity is not present, repair or replace wire 503 (ref. p. 8-74). If lead has continuity replace starter protection relay. If problem persists replace alternator (ref. p. 8-5).

ENGINE	ENGINE CRANKS BUT DOESN'T START.

1 Check fuel level. Fill tanks to visible level.

2 Check main fuel hose for proper connection at primary fuel filter (ref. p. 6-14).

3 Clean primary fuel filter and replace element (ref. p. 6-14).

4 Clean secondary fuel filter and replace element (ref. p. 6-16).

5 Check for pinched, kinked, or plugged fuel tubes or hoses. Replace if damaged (ref. p. 6-2 and 6-24).

6 Test engine fuel pump (ref. p. 6-18).

ENGINE	ENGINE DOESN'T ACCELERATE PROPERLY.

1 Adjust hand throttle control rod and accelerator pedal (ref. p. 9-51 and 9-53).

2 Check brake adjustment (ref. p. 9-25 and 9-45).

3 Perform fuel flow test (ref. p. 6-26).

ENGINE	ENGINE DOESN'T KEEP STEADY SPEED.

1 Check to see if engine coolant is at operating temperature of 170°F (77°C).

2 Check accelerator and throttle linkage for loose mounting bolts.

3 Check primary fuel filter. Replace filter element, if required (ref. p. 6-14).

ENGINE	ENGINE DOESN'T DEVELOP FULL POWER. Engine runs slowly and idles roughly.

1 Check to see if engine coolant is at operating temperature of 170°F (77°C).

2 Remove air cleaners. Clean if clogged (ref. p. 6-33).

3 Check for proper accelerator pedal adjustment. Adjust if required (ref. p. 9-53).

4 Perform fuel flow test (ref. p. 6-26).

ENGINE	ENGINE USES OIL.

Check for external oil leaks. Correct cause of leaks if within scope of Organizational Maintenance. If not, notify Support Maintenance.

ENGINE	ENGINE USES TOO MUCH FUEL.

1 Inspect fuel tanks, lines and connections for leaks. Tighten loose connections. Replace any damaged fuel lines. Notify Direct Support Maintenance to repair fuel tank leaks.

2 Check for dirty air filters. Clean if necessary (ref. p. 6-33).

ENGINE	BLACK EXHAUST SMOKE IS PRESENT.

1 Check air filter for restricted air flow. Clean if necessary (ref. p. 6-33).

2 If smoke persists, notify Support Maintenance.

ENGINE	WHITE EXHAUST SMOKE IS PRESENT.

1 Drain and clean fuel filters to remove contaminated fuel (ref. p. 6-14 and 6-16).

2 Check radiator for consistently low coolant level and oil contamination.

3 If smoke persists, notify Support Maintenance.

ENGINE	EXHAUST FUMES ARE PRESENT IN CREW COMPARTMENT. Eyes burn and exhaust smell is present.

1 Check for leak at exhaust tail pipe connections.

2 Remove engine compartment access cover and inspect gasket for serviceability (ref. p. 11-20).

3 Inspect all clamps and pipes for damage. Tighten clamps if necessary.

4 Check personnel heater exhaust system.

ENGINE	ENGINE HAS LOW OR NO OIL PRESSURE.

1 Check engine oil level. Level should be between ADD and FULL marks on dipstick (ref. LO 9-2350-311-12).

2 Check for oil leaks. Correct cause of any leaks if within the scope of Organizational Maintenance.

3 If problem persists, notify Support Maintenance.

ENGINE	ENGINE OVERHEATS.

1 Check coolant level. Add coolant if necessary (ref. TM 9-2350-311-20-10).

2 Check cooling fans for proper operation (ref. p. 2-42).

3 Check grilles and radiator for clogged air passages. Clean if necessary (ref. p. 2-44).

4 Check for collapsed hoses. Replace if necessary.

5 Clean and flush cooling system (ref. p. 2-45 and TM 9-2350-311-10).

6 Remove and replace inlet and bypass thermostats (ref. p. 7-20 and 7-22).

ENGINE	ENGINE OVERHEATS - CONT'D

7 Replace pressure relief valve (ref. p. 7-11).

8 Troubleshoot engine coolant temperature indicator circuit (ref. p. 3-58).

TRANSMISSION AND DRIVING CONTROLS	TRANSMISSION OVERHEATS. TRANSMISSION OIL TEMP gage is over/under 270° (132°C). Master warning light is lit.

1 Check oil level and add oil if necessary (ref. LO 9-2350-311-12).

2 Adjust brakes (ref. p. 9-45).

3 Check transmission oil filter for cleanliness and proper installation (ref. p. 9-9).

4 Check transmission oil pressure (ref. p. 9-2). If below specified pressure, notify Support Maintenance.

TRANSMISSION AND DRIVING CONTROLS	VEHICLE DOESN'T DRIVE. Transmission doesn't operate in any shift position.

1 Check for improperly adjusted or disconnected shift control linkage. Connect linkage or adjust properly (ref. p. 9-19).

2 Check brake linkage (ref. p. 9-25) and transmission internal brake adjustment (ref. p. 9-45). Adjust as required.

3 Check oil level and add as required (ref. LO 9-2350-311-12). If oil level is low, check transmission seals, plugs and gaskets for oil leaks. Correct cause of leaks if within scope of Organizational Maintenance. If repairs are beyond scope of Organizational Maintenance, notify Support Maintenance.

4 Check oil pressure (ref. p. 9-2). If below specified pressure, notify Support Maintenance.

5 Check for broken universal joints. if broken, replace (ref. p. 10-45).

6 Road test vehicle to ensure problem is corrected.

TRANSMISSION AND DRIVING CONTROLS	VEHICLE DOESN'T STEER IN EITHER DIRECTION IN ANY RANGE.

1 Check for broken or disconnected steering linkage. Connect steering linkage (ref. p. 9-12).

2 Check transmission oil level (ref. LO 9-2350-303-12).

TRANSMISSION AND DRIVING CONTROLS	VEHICLE STEERS GOOD IN ONE DIRECTION ONLY.

1 Check steering control linkage adjustment (ref. p. 9-12).

2 Check transmission oil pressure (ref. p. 9-2). If below specified pressure, notify Support Maintenance.

TRACKS AND SUSPENSION	VEHICLE BRAKES POORLY. Vehicle doesn't stop correctly when brake is used.

1 Check for improperly adjusted brakes. Adjust if necessary (ref. p. 9-25).

2 Check for faulty brake linkage. Replace brake linkage if defective (ref. p. 9-25).

TRACKS AND SUSPENSION	VEHICLE PULLS TO ONE SIDE WITH STEERING WHEEL IN CENTER POSITION.

NOTE

Crown on road causes vehicle to pull away from center of road. Road test vehicle on flat surface.

1 Check for disconnected or improperly adjusted steering control linkage (ref. p. 9-12).

2 Check brakes. Adjust if necessary (ref. p. 9-25).

3 Check track and suspension (ref. p. 2-37 and 2-39).

4 Check for worn drive sprocket (ref. p. 2-38).

TRACKS AND SUSPENSION	VEHICLE THROWS TRACK.

NOTE

Improper driving or operation of vehicle (high speed turns) causes vehicle to throw track.

1 Check for loose or worn track (ref. p. 10-9). Replace as required (ref. p. 10-4).

2 Check for broken torsion bars. Replace if broken (ref. p. 10-20).

TRACKS AND SUSPENSION	SUSPENSION SYSTEM IS NOISY DURING OPERATION.

1 Immediately after operating vehicle, check road wheel hubs for excessive heat (ref. p. 10-14).

2 Check for excessive sprocket wear. Reverse or replace (ref. p. 10-40).

3 Check for worn track shoes (ref. p. 10-4).

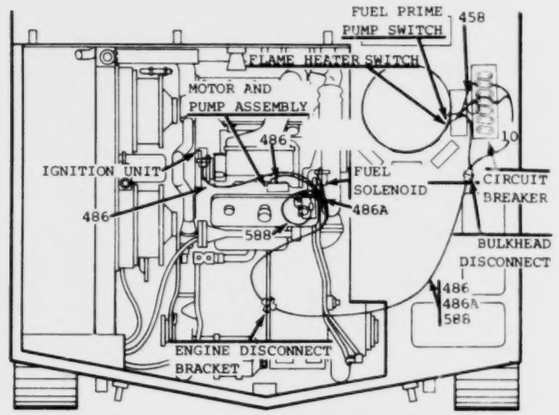
FLAME HEATER	FLAME HEATER DOESN'T OPERATE. Motor and pump assembly doesn't operate. Do steps A through D. Fuel solenoid doesn't operate. Do steps E through J. Fuel prime pump doesn't operate. Do steps L through P. Ignition unit doesn't operate. Do steps Q through R.

With MASTER switch ON and fuel shutoff pulled, crank engine. A small amount of smoke should come out of exhaust when flame heater is turned on. If not, troubleshoot flame heater circuit.

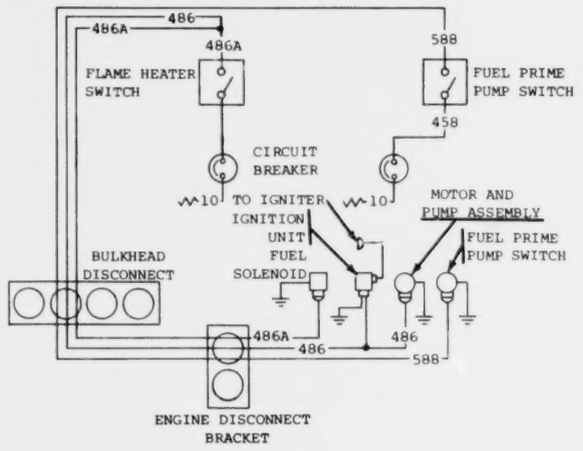
NOTE

If vehicle has flame heater master switch, flame heater parts kit 12268166 must be installed before troubleshooting flame heater circuit.

FLAME HEATER CIRCUIT

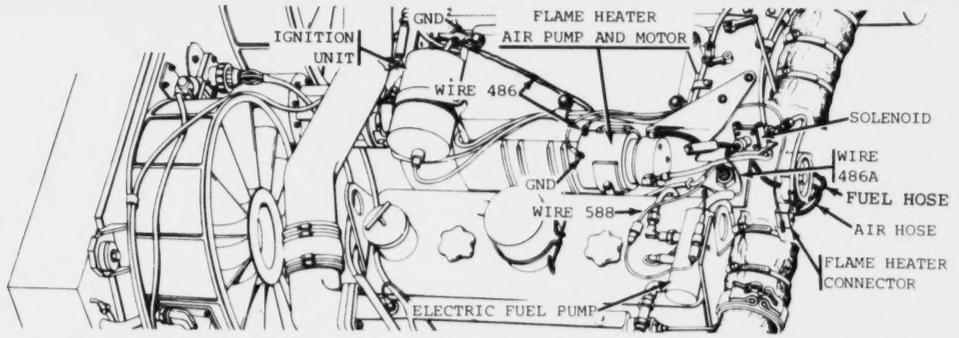


PICTORIAL VIEW

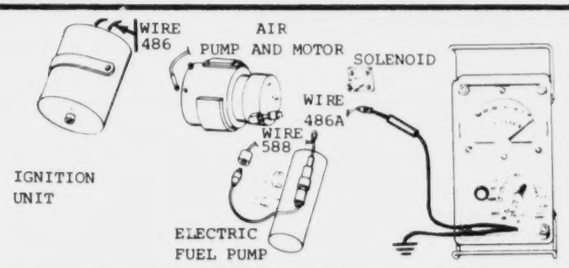


ELECTRICAL DIAGRAM

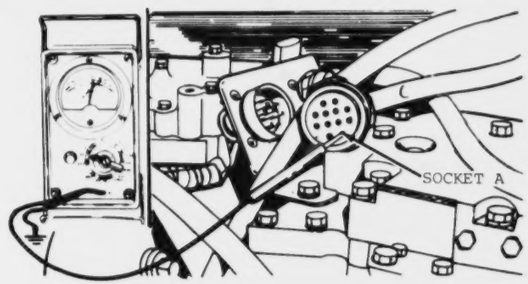
TA472041



A Disconnect wire 486A from flame heater solenoid, wire 486 from flame heater air pump and motor assembly, wire 486 from ignition unit and wire 588 at electrical fuel pump.

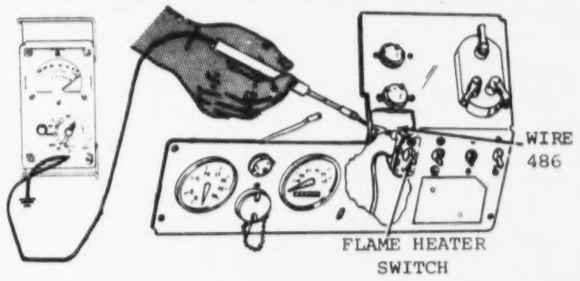


B Place multimeter red lead in wire 486A, black lead to ground. Place MASTER switch and FLAME HEATER switch to the ON position - test for voltage. Repeat voltage checks for both wires 486 and 588. If no voltage on wire 486 to pump and motor assembly, go to step C. If no voltage on wire 486A (solenoid), go to step H. If no voltage on wire 486 (ignition unit), go to step K. If no voltage on wire 588 (electric fuel pump), go to step L.

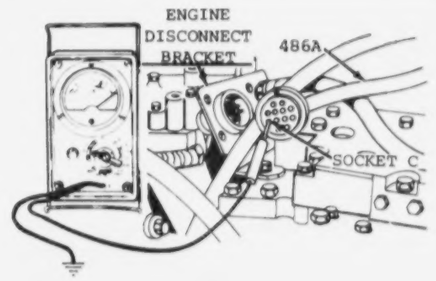


C Disconnect connector at engine disconnect bracket. Turn MASTER switch ON. Place red multimeter lead in socket A. Ground black lead and check for voltage. If voltage to ignition unit is present, repair or replace wire 486 from engine disconnect bracket to motor and pump assembly (ref. p. 8-70). If no voltage, go to step D.

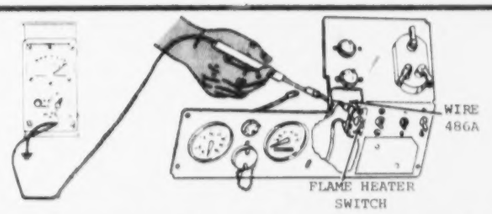
TA472042



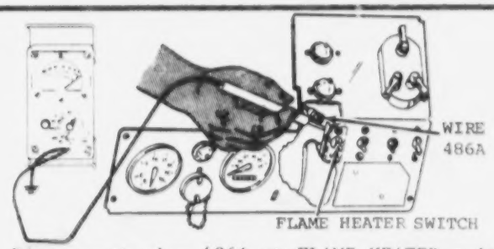
D Disconnect wire 486 from FLAME HEATER switch lead. Turn MASTER switch ON. With FLAME HEATER switch on, check switch lead for voltage by placing red lead in switch lead connector and black lead to ground. If no voltage, go to step G. If voltage is present, repair or replace wire 486 from FLAME HEATER switch lead to engine disconnect bracket (ref. p. 8-124).



E Disconnect wire 486A at engine disconnect bracket. Turn MASTER switch ON. Check for voltage in socket C by placing red multimeter lead in socket C and black lead to ground. If voltage is present, repair or replace wire 486A from engine disconnect bracket to fuel solenoid (ref. p. 8-70). If no voltage, go to step F.

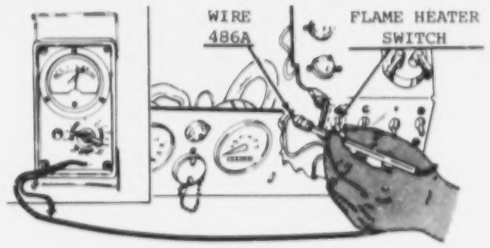


F Disconnect wire 486A at FLAME HEATER switch lead. With MASTER and FLAME HEATER switches on, check switch lead for voltage by placing red multimeter lead in switch lead connector and black lead to ground. If voltage is present, repair or replace wire 486A from FLAME HEATER switch lead to engine disconnect bracket (ref. p. 8-80). If no voltage is present, go to step G.

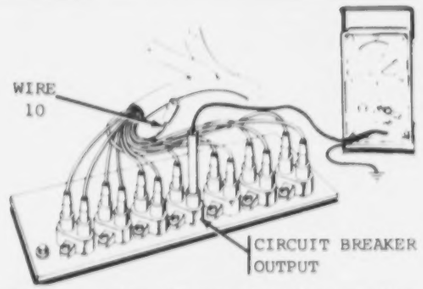


G Disconnect wire 486A at FLAME HEATER switch output. With MASTER and FLAME HEATER switches on, check switch for voltage by placing red multimeter lead in switch and black lead to ground. If voltage is present, repair or replace switch lead 486A (ref. p. 8-80). If no voltage is present, go to step H.

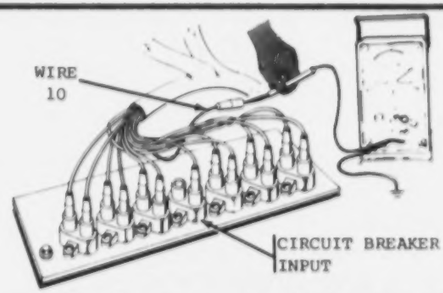
TA472043



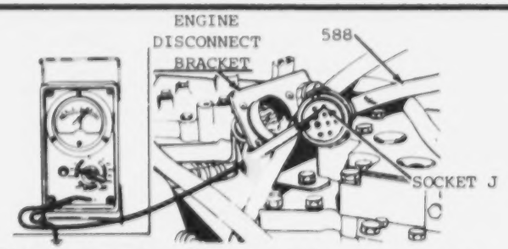
H Disconnect wire 10 at FLAME HEATER switch input voltage. Turn MASTER switch ON. Place red multimeter lead in wire 486A and black lead to ground. If voltage is present, replace FLAME HEATER switch (ref. p. 8-22). If voltage is not present, go to step I.



I Disconnect wire 10 at circuit breaker output. Turn MASTER switch ON. Check circuit breaker for voltage by placing red multimeter lead in circuit breaker output and black lead to ground. If voltage is present, repair or replace wire 10 to FLAME HEATER switch (ref. p. 8-90). If no voltage is present, go to step J.

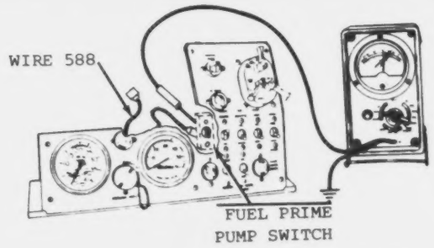


J Disconnect wire 10 at circuit breaker input. Turn MASTER switch ON. Check wire 10 for voltage by placing red lead of multimeter in wire and black lead to ground. If voltage is not present, repair wire 10 feed circuit from bulkhead disconnect to circuit breaker (ref. p. 8-12 or 8-103).

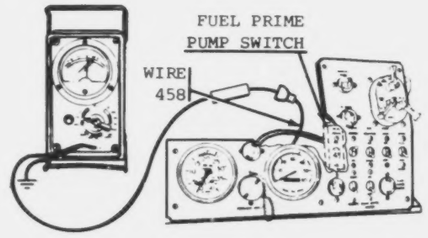


K Disconnect wire 588 at engine disconnect bracket. With MASTER switch ON, place multimeter red lead in socket J and black lead to ground. FUEL PRIME pump switch to ON position and check for voltage. If voltage present, repair or replace wire 588 from engine disconnect bracket to fuel prime pump. If voltage is not present, go to step L.

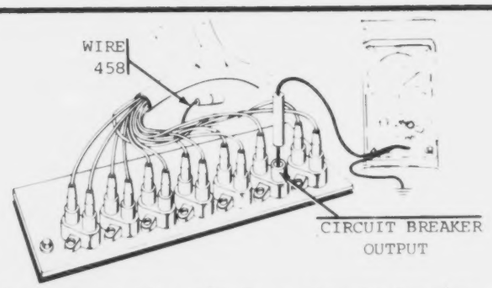
TA472044



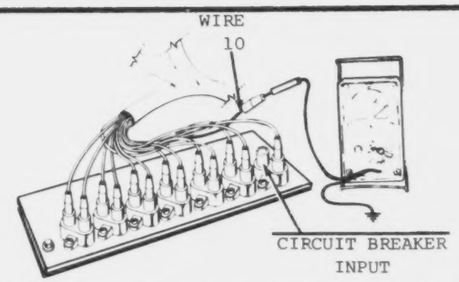
L Disconnect wire 588 from FUEL PRIME pump switch. With MASTER switch ON, place multimeter red lead in switch output and black lead to ground. FUEL PRIME pump switch to the ON position and check for voltage. If voltage is present, repair or replace wire 588 from switch to engine disconnect bracket. If voltage is not present, go to step M.



M Disconnect wire 458 from FUEL PRIME pump switch input. With MASTER switch ON, place multimeter red lead in wire 458, and black lead to ground. Check for voltage. If voltage is present, replace FUEL PRIME pump switch. If voltage is not present, go to step N.

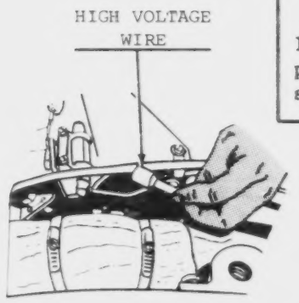


N Disconnect wire 458 from circuit breaker output. With MASTER switch ON, place multimeter red lead in circuit breaker output and black lead to ground. Check for voltage. If voltage is present, replace or repair wire 458. If voltage is not present, go to step O.



O Disconnect wire 10 from circuit breaker input. Multimeter red lead on wire 10 and black lead to ground. Check for voltage. If voltage is present, replace circuit breaker (ref. p. 8-62). If voltage is not present, troubleshoot master relay circuit (ref. p. 3-13).

TA472045



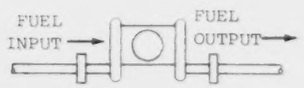
WARNING

If fuel vapors are present, do not do step P.

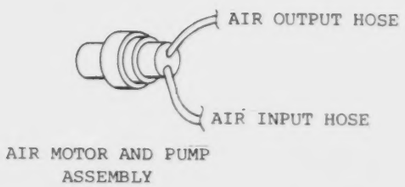
P Disconnect high voltage wire from igniter and hold wire 1/4 inch (6.4 mm) from ground. FLAME HEATER switch ON. If spark fails to jump 1/2 inch (6.4 mm) gap, replace ignition unit.

CAUTION

Use a container to catch any fuel that may flow out the input hose.



Q Disconnect fuel input hose at solenoid. FLAME HEATER switch and FUEL PRIME pump switch-ON. If fuel flows freely, replace solenoid. If fuel does not flow, notify Support Maintenance.



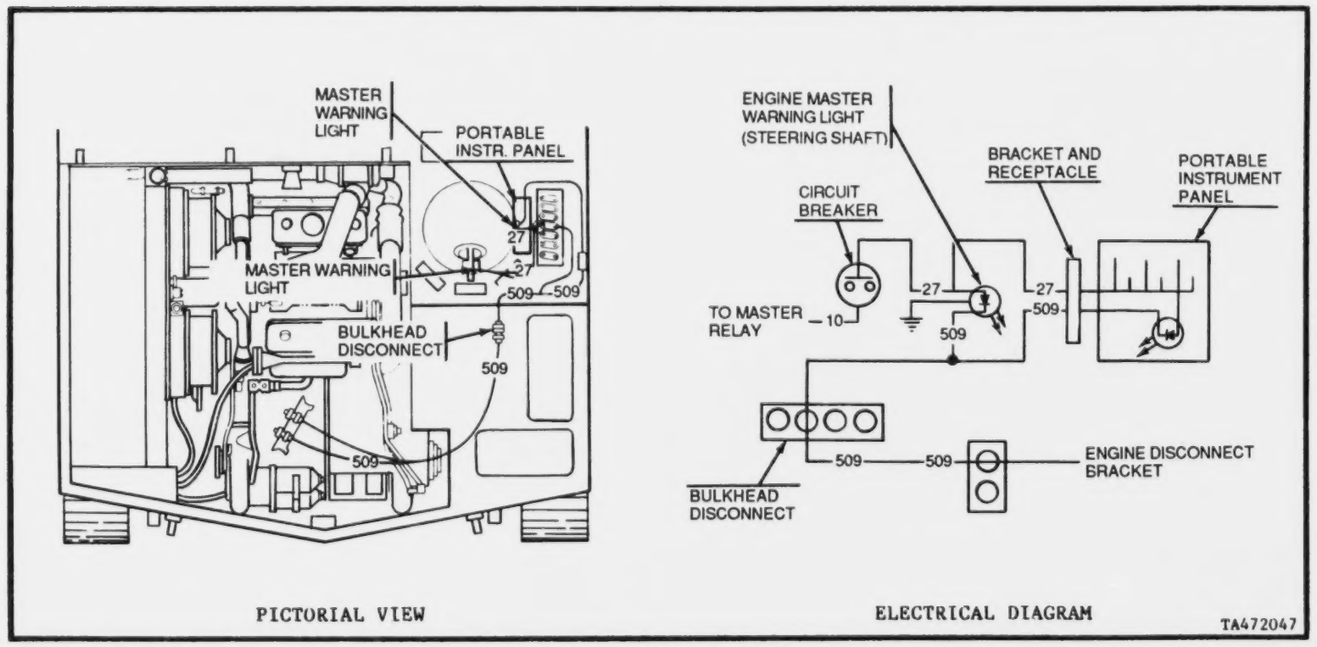
R Disconnect air output hose at the motor and pump assembly. FLAME HEATER switch ON. If air does not flow from the port, notify Support Maintenance.

TA472046

ENGINE MASTER WARNING LIGHT (STEERING SHAFT)	MASTER WARNING LIGHT DOESN'T LIGHT. Do steps A and B. MASTER WARNING LIGHT DOESN'T LIGHT WHEN PRESS-TO-TEST IS PERFORMED. Do step C.

Troubleshoot engine master warning light circuit.

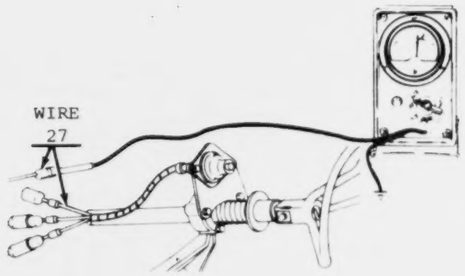
MASTER WARNING LIGHT CIRCUIT



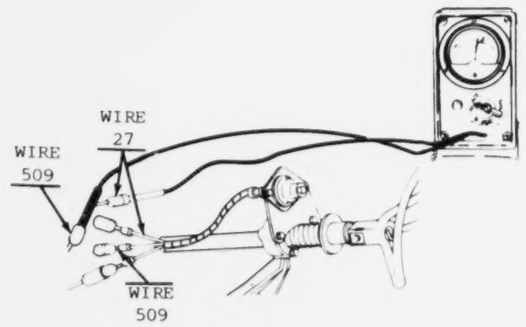
PICTORIAL VIEW

ELECTRICAL DIAGRAM

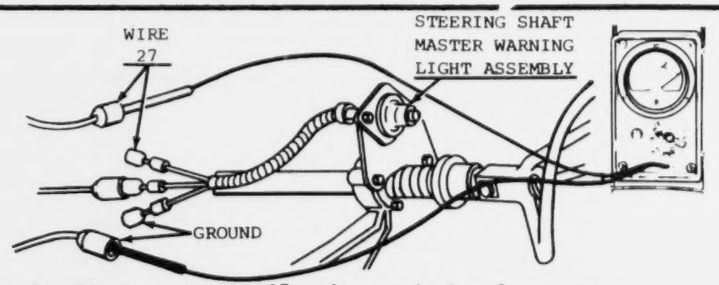
TA472047



A Disconnect wire 27 from master warning light. Then turn MASTER switch ON. Using multimeter set on dc volts scale, place red lead in wire 27 and ground black lead to hull. If voltage is present, go to step B. If no voltage, repair or replace wire 27 (ref. p. 8-134.2).



B Disconnect wire 509 from master warning light. Turn MASTER switch ON. With red multimeter lead in wire 27, place black lead in wire 509. If voltage is present, replace bulb (ref. p. 8-134.2). If no voltage, repair wire 509 (ref. p. 8-134.2).



C Disconnect wire 27 and ground wire from master warning light. Turn MASTER switch ON. Using multimeter, place red lead in wire 27 and black lead in ground wire. If voltage is present, replace steering shaft master warning light assembly (ref. p. 8-134.2). If no voltage, repair or replace ground wire (ref. p. 8-134.2).

TA472048

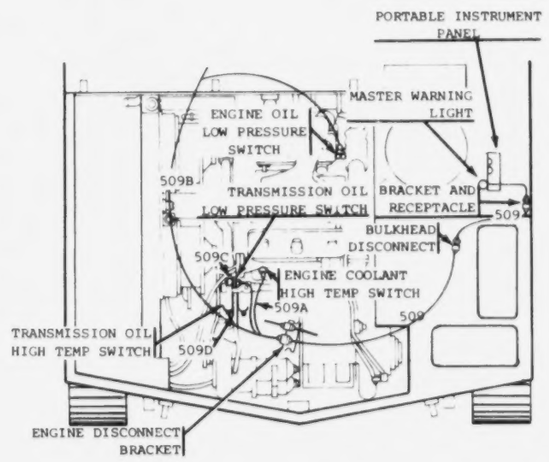
ENGINE MASTER WARNING LIGHT (PORTABLE INSTRUMENT PANEL)	MASTER WARNING LIGHT DOESN'T LIGHT MASTER switch is ON and engine is off, but master warning light isn't lit. Do steps A and B. MASTER WARNING IS LIT. Everything appears normal, but master warning light is lit. Do steps C through F.

Troubleshoot engine master warning light circuit.

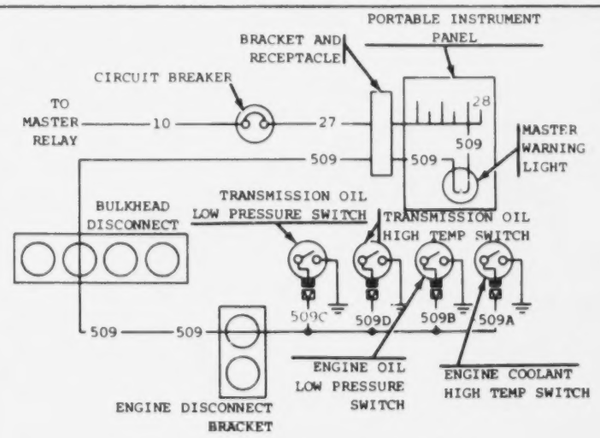
MASTER WARNING LIGHT CIRCUIT

WARNING

When working in the powerplant compartment with engine running, use extreme care. Wear appropriate protective devices and clothing. Keep hands clear of moving parts.

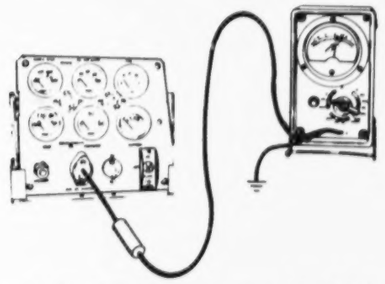


PICTORIAL VIEW

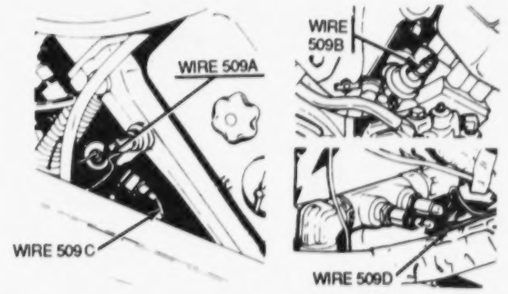


ELECTRICAL DIAGRAM

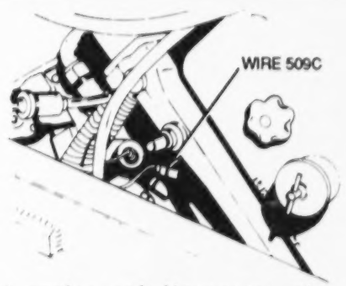
TA472049



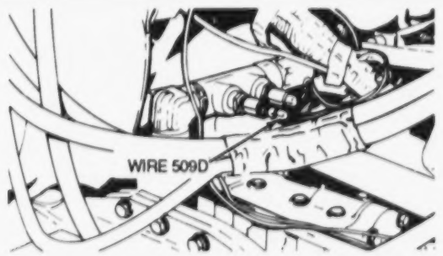
A Remove bulb from master warning light. Turn MASTER switch ON. Put red multimeter lead in center contact, ground black lead, and check voltage. If no voltage, troubleshoot wire 509 from center contact to junction of wires 509 and 28 (ref. p. 8-106). If voltage is present, go to step B. Repair if required.



B Place a good bulb in master warning light socket. If bulb lights, old bulb was bad and the wiring is good.

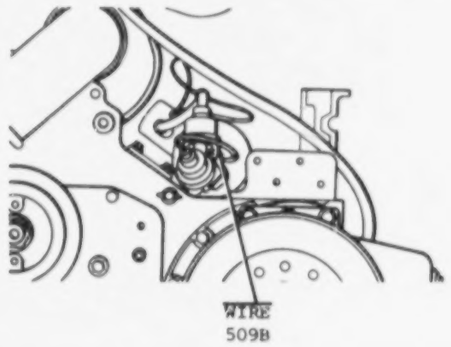


C Start engine and disconnect wire 509C while watching master warning light. If light goes out, replace transmission oil low pressure switch (ref. p. 8-16). If light stays on, go to step D. If light stays off, troubleshoot switch and go to step B.

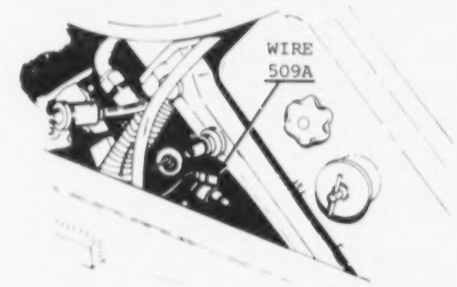


D With engine operating, disconnect wire 509D while observing master warning light. If light goes cut, replace transmission oil high temperature switch (ref. p. 8-15). If light continues to burn, troubleshoot switch and go to step E.

TA472050



E Remove engine compartment access cover. With engine running, disconnect wire 509B from engine oil pressure transmitter. If master warning light goes out, replace engine oil low pressure switch (ref. p. 8-12). If light continues to burn, troubleshoot switch and go to step F.



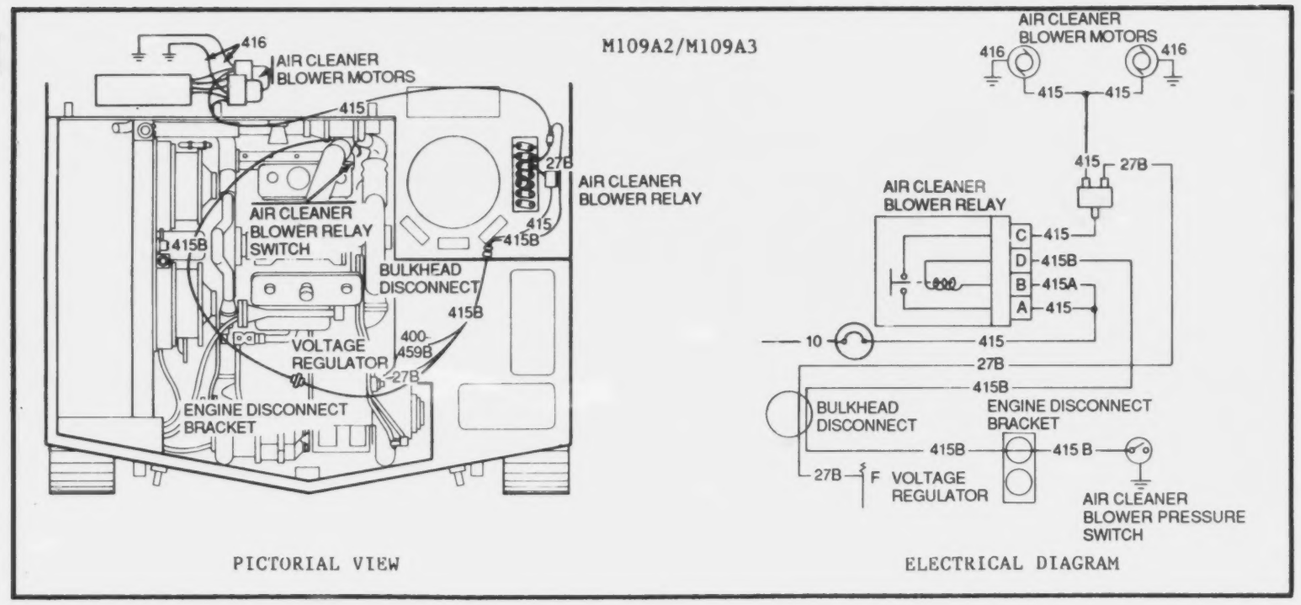
F With engine running, disconnect wire 509A from engine coolant high temperature switch. If master warning light goes out, replace engine coolant high temperature switch (ref. p. 8-10). If light continues to burn, troubleshoot switch.

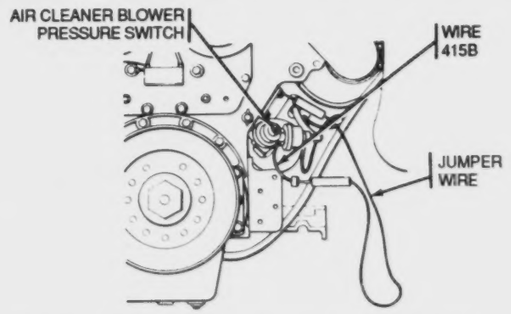
TA472051

AIR CLEANER BLOWER MOTOR (M109A2/M109A3)	MOTOR DOESN'T OPERATE. Do steps A through H. Engine is running, but blower motor doesn't operate. MOTOR DOESN'T STOP. Do steps I and J. Engine is off and MASTER switch is on, and motor runs. ONE BLOWER MOTOR DOESN'T OPERATE. Do step K.

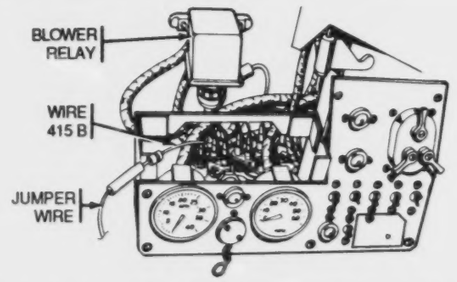
Troubleshoot air cleaner blower motor circuit.

AIR CLEANER BLOWER MOTOR CIRCUIT.

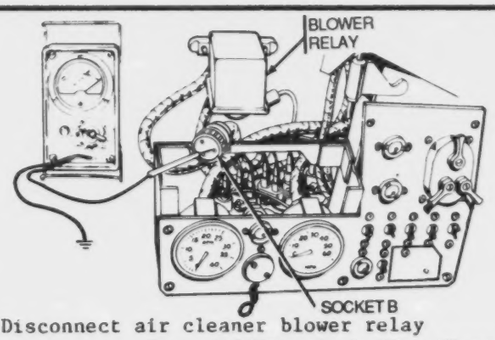




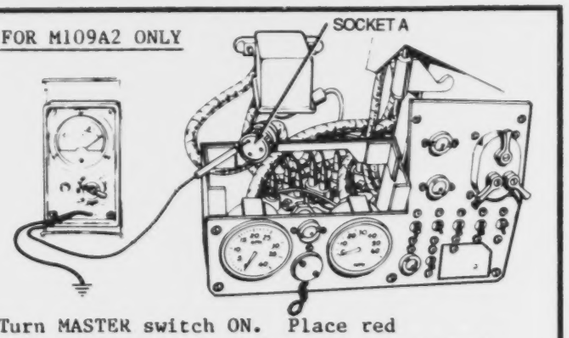
A Remove engine compartment access cover. Disconnect wire 415B from air cleaner blower pressure switch. Turn MASTER switch ON and use jumper wire to ground wire 415B. If blower motors operate, replace switch (ref. p. 8-14). If blower motors fail to operate, go to step B.



B Disconnect wire 415B at air cleaner blower relay. Turn MASTER switch ON. Using jumper, ground wire 415B (lead from blower relay). If blower motors operate, replace wire 415B from air cleaner blower relay to air cleaner blower pressure switch (ref. p. 8-70.2). If motor fails to operate, go to step C.



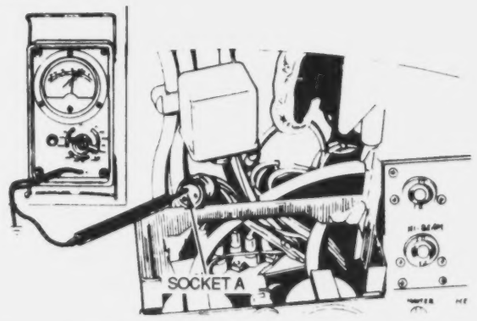
C Disconnect air cleaner blower relay connector. Turn MASTER switch ON. Place red multimeter in socket B and ground black lead. If no voltage, repair or replace wire 415A (ref. p. 8-130). If voltage is present, go to step D.



D-1 Turn MASTER switch ON. Place red multimeter lead in socket A, ground black lead, and check for voltage, repair wire 415. If no voltage is present, repair wire 415 (ref. p. 8-130). If voltage is present, go to step E-1.

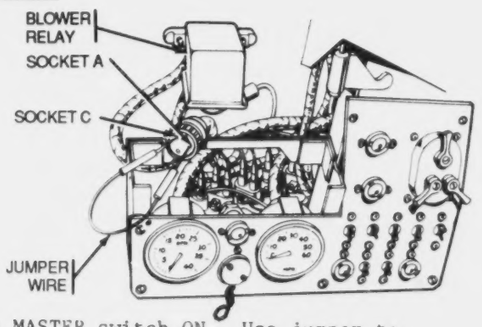
TA472053

M109A3 ONLY



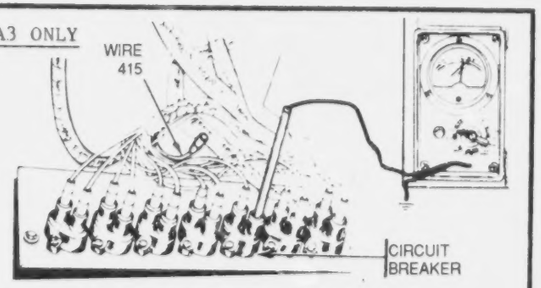
D-2 Turn MASTER switch ON. Place red multimeter lead in socket A, ground black lead, and check for voltage. If no voltage, go to step E-2. If voltage is present, go to step G-2.

M109A2 ONLY



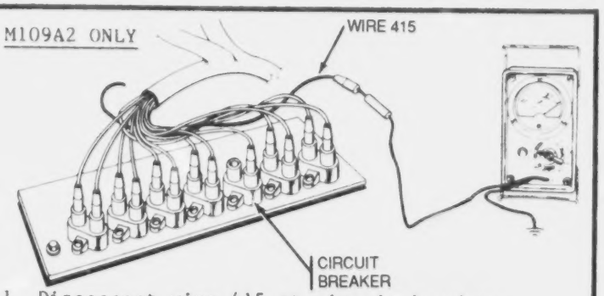
E-1 Turn MASTER switch ON. Use jumper to connect socket A to socket C. If blower motors operate, replace air cleaner blower relay (ref. p. 8-64.2). If blower motors fail to operate, leave jumper wire connected and go to step F-1.

M109A3 ONLY



E-2 Disconnect wire 415 at circuit breaker. Turn MASTER switch ON. Place red multimeter lead in circuit breaker output, ground black lead, and check for voltage. If voltage is present, repair wire 415 (ref. p. 8-130). If no voltage, go to step F-2.

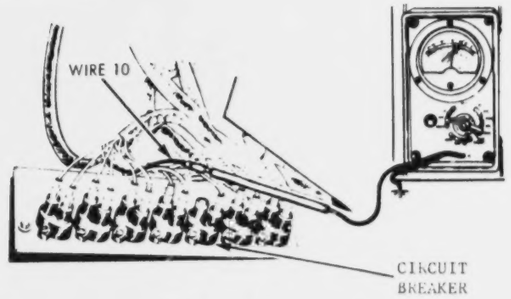
M109A2 ONLY



F-1 Disconnect wire 415 at circuit breaker. Turn MASTER switch ON. Place red multimeter lead in wire 415, ground black lead and check for voltage. If voltage is not present, repair or replace wire 415 (ref. p. 8-126). If voltage is present, leave jumper wire connected and go to step G-1.

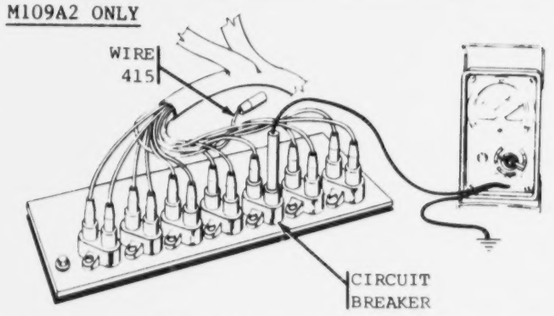
TA472054

M109A3 ONLY



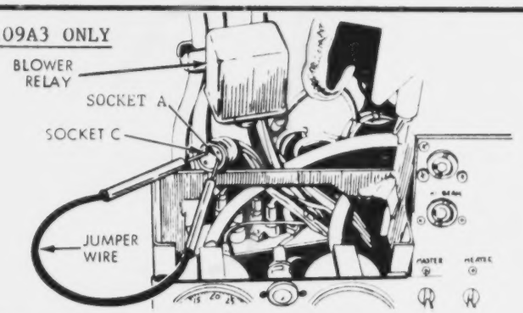
F-2 Disconnect wire 10 at circuit breaker. Turn MASTER switch ON. Place red multimeter lead in wire 10, ground black lead, and check for voltage. If voltage is present, replace circuit breaker (ref. p. 8-62). If no voltage, repair or replace wire 10 (ref. p. 8-100).

M109A2 ONLY



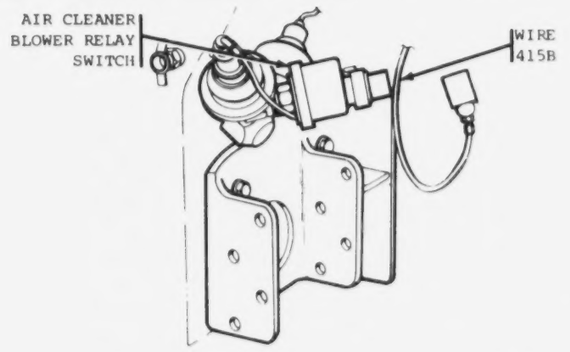
G-1 Disconnect wire 415 at circuit breaker. Turn MASTER switch ON. Place red multimeter lead in circuit breaker output, ground black lead, and check for voltage. If no voltage, replace circuit breaker (ref. p. 8-62). If voltage is present, leave jumper wire connected and go to step H.

M109A3 ONLY

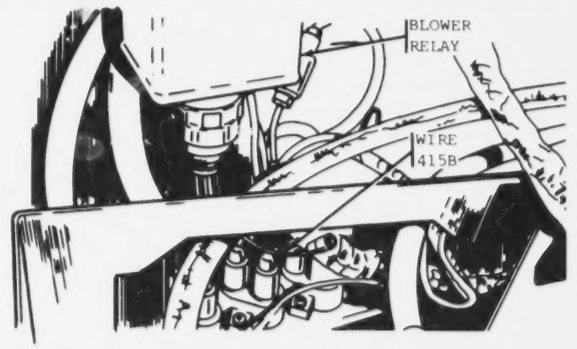


G-2 Turn MASTER switch ON. Use jumper to connect socket A to socket C. If blower motors operate, replace air cleaner blower relay (ref. p. 8-64). If blower motors fail to operate, go to step H.

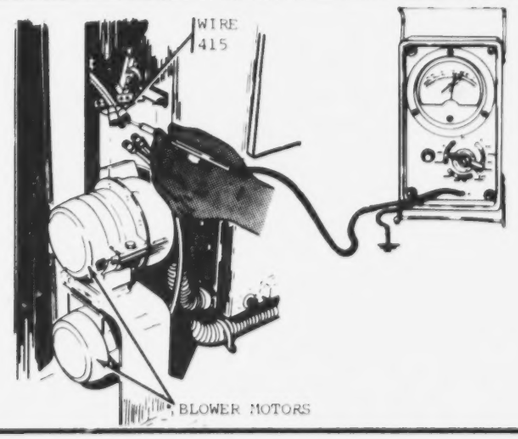
H Reconnect all connectors and wires. Disconnect wire 415 from each blower motor and start engine. Wait for engine oil pressure to build above 12 psi (0.8 Kg/cm^2). Check both wires 415 for voltage, using multimeter with red lead in wire and black lead grounded. If no voltage, repair or replace wires 415. If voltage is present, replace blower motors (ref. p. 8-64). TA472055



I Remove engine compartment access cover. Turn MASTER switch ON. Disconnect wire 415B from air cleaner blower pressure switch. If blower motors stop, replace relay switch. If blower motors continue to operate, reconnect wire and go to step J.



J Disconnect wire 415 B from air cleaner blower relay. Turn MASTER switch on. If blower motors stop, repair or replace wire 415 B from blower relay to blower pressure switch (ref. p. 8-130). If blower motors continue to operate, replace blower relay (ref. p. 8-64).



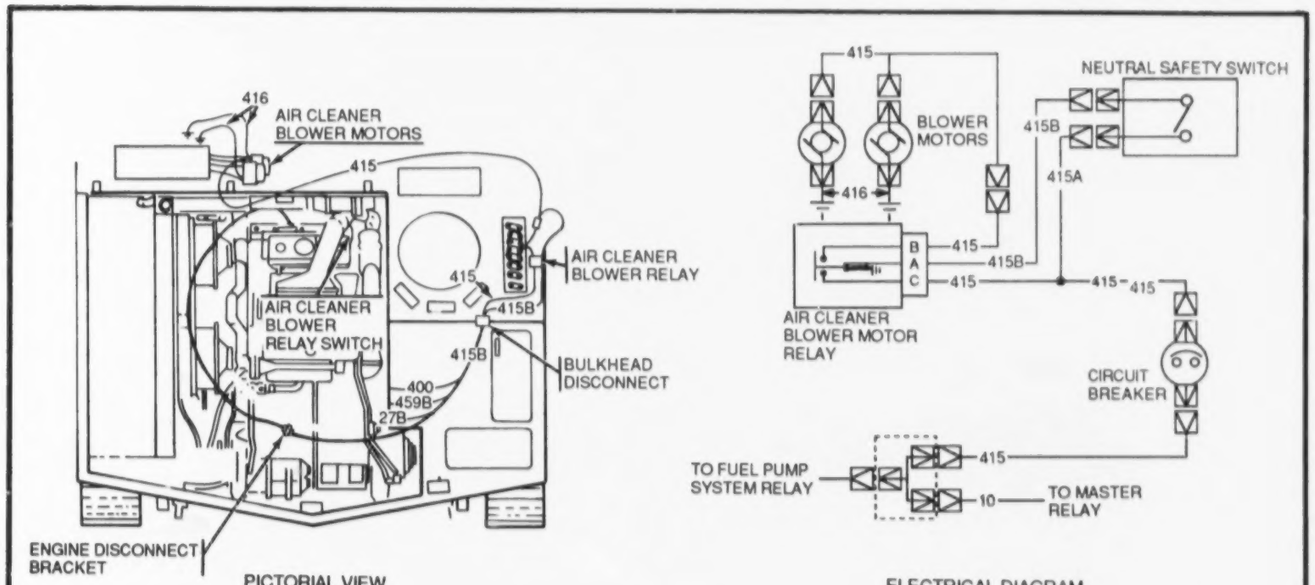
K Start engine and wait for engine oil pressure to build above 12 psi (0.8 Kg/cm^2). Disconnect wire 415 at disabled blower motor and check for voltage. If no voltage, repair or replace wire 415 (ref. p. 8-94). If voltage is present, replace blower motor (p. 8-64).

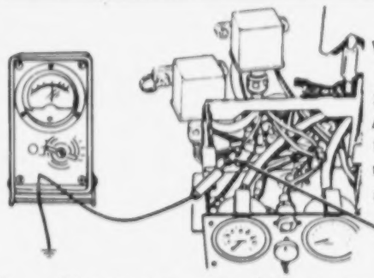
TA472056

AIR CLEANER BLOWER MOTOR (M109A4)	BLOWER MOTORS DON'T OPERATE. Do steps A through J. Vehicle is in drive but blower motors don't operate. ONE BLOWER MOTOR DOESN'T OPERATE. Do step K. BLOWER MOTORS DON'T STOP. Do step L. Vehicle is in nuetral and MASTER switch is on, and blower motors run.

Troubleshoot air cleaner blower motor circuit.

M109A4 AIR CLEANER BLOWER MOTOR CIRCUIT.

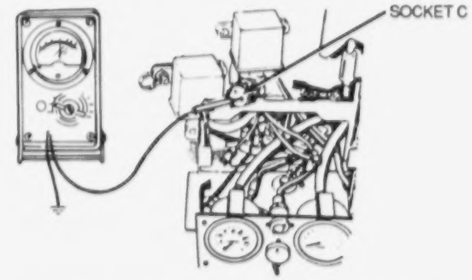




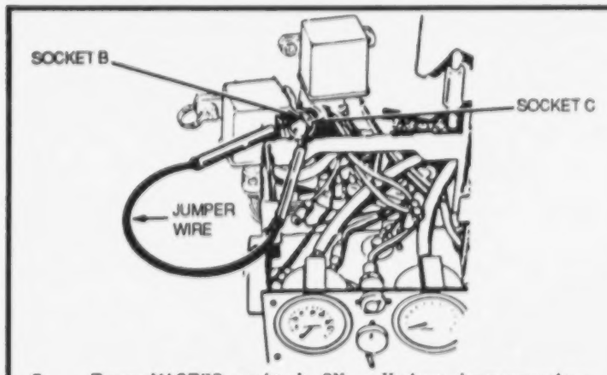
NOTE

Vehicle must be in 1st gear in order for fans to operate. All steps require this condition unless otherwise stated.

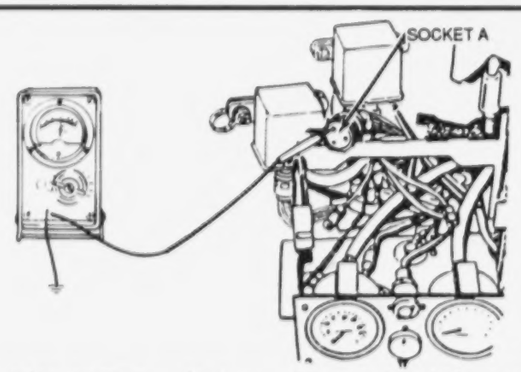
A Disconnect wire 415 at accessory control box wiring harness. With MASTER switch ON place red multimeter lead in wire 415 and black to ground. Check for voltage. If voltage is present repair or replace accessory control box wiring harness (ref. p. 8-94). If voltage is not present proceed to step B.



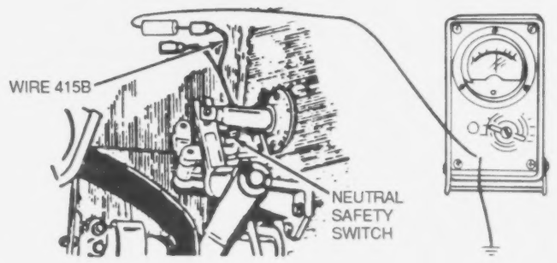
B Disconnect connector at air cleaner blower relay. With MASTER switch ON place red multimeter lead in socket C and black to ground. Check for voltage. If voltage is present, leave harness disconnected and go to step C. If voltage is not present go to step G.



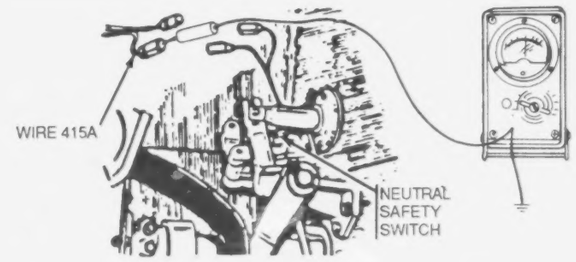
C Turn MASTER switch ON. Using jumper wire connect sockets C and B. If blower motors operate do not connect harness and go to step D. If motors do not operate repair or replace wire 415 from air cleaner blower relay (ref. p. 8-132).



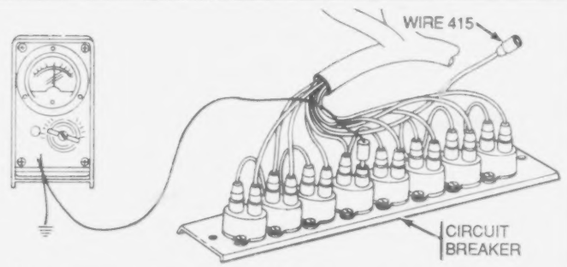
D With MASTER switch on place red multimeter lead in socket A and black lead to ground. Check for voltage. If voltage is present replace air cleaner blower relay (ref. p. 8-66). If voltage is not present go to step E.



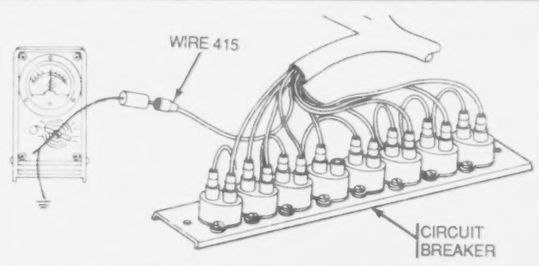
E Disconnect wire 415B at neutral safety switch. With MASTER switch ON place red multimeter lead in connector and black lead to ground. Test for voltage. If voltage is present, replace or repair air cleaner blower wire 415B (ref. p. 8-132). If no voltage is present, go to step F.



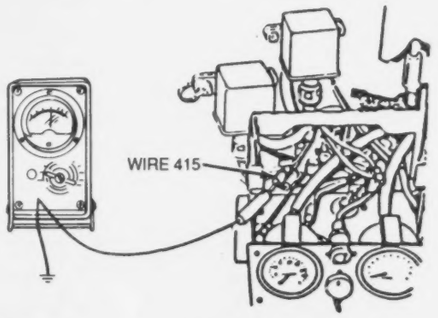
F Disconnect wire 415A at neutral safety switch. With MASTER switch ON place red multimeter lead in wire 415A and black lead to ground. Check for voltage. If voltage is present, replace neutral safety switch (ref. p. 8-18). If voltage is not present go to step G.



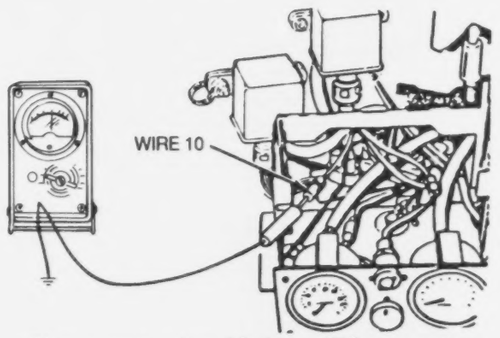
G Disconnect connector 415 at output side of circuit breaker. With MASTER switch ON place red multimeter lead in circuit breaker and black lead to ground. Test for voltage. If voltage is present, repair or replace air cleaner blower relay wiring harness (ref. p. 8-132). If voltage is not present, go to step H.



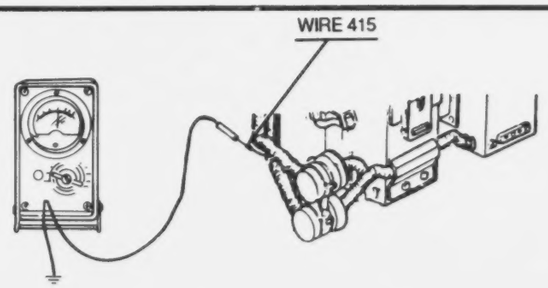
H Disconnect wire 415 from input side of circuit breaker. With MASTER switch ON, place red multimeterr lead in wire 415 and black lead to ground. Check for voltage. If voltage is present, replace circuit breaker (ref. p. 8-64). If no voltage is present, go to step I.



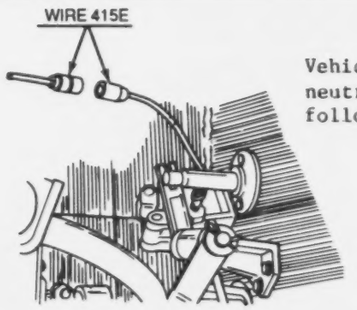
I Disconnect wire 415 at "Y" connector. With MASTER switch ON, place red multimeter lead in "Y" connector and black to ground. Test for voltage. If voltage is present, repair or replace wire 415 (ref. p. 8-128). If no voltage is present, go to step J.



J Disconnect wire 10 from "Y" connector. With MASTER switch ON place red multimeter lead in wire 10 and black to ground. Check for voltage. If voltage is present replace "Y" connector. If voltage is not present repair or replace wire 10 (ref. p. 8-106).



K Disconnect wire 415 from the disabled blower motor. With MASTER switch ON, place red multimeter lead in wire 415 and black to ground and check for voltage. If voltage is present, replace blower motor (ref. p. 8-64.2). If voltage is not present repair or replace wire 415 (ref. p. 8-94).



NOTE

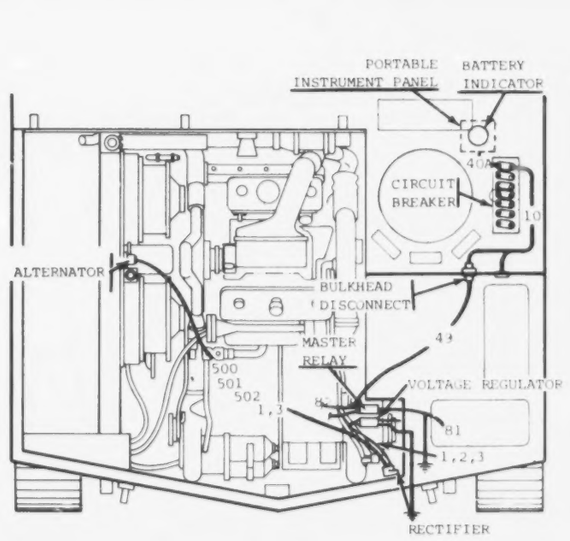
Vehicle must be in neutral for the following step.

L With MASTER switch ON disconnect wire 415E at neutral safety switch. If motors stop operating, replace neutral safety switch (ref. p. 8-18). If motors continue to operate, replace air cleaner blower relay (ref. p. 8-66).

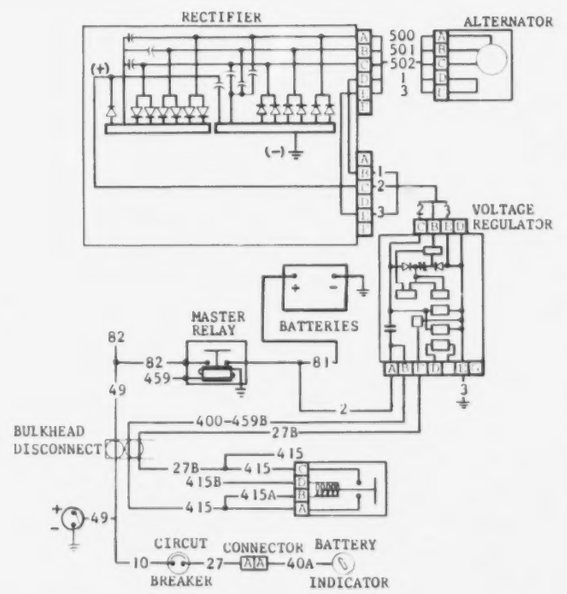
ALTERNATOR (M109A2 ONLY)	CHARGING SYSTEM DOESN'T OPERATE. Do steps A through M. Gage shows not charging with engine running or isn't steady or accurate. BATTERY IS OVERCHARGING. Do step N, only if vehicle is equipped with an adjustable regulator. If not, go to step M. BATTERY gage is in right red.

Troubleshoot charging system circuit.

CHARGING SYSTEM CIRCUIT

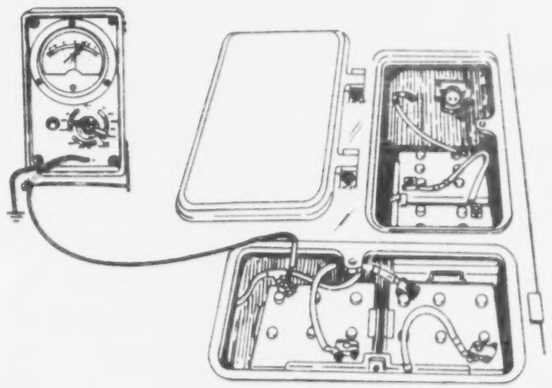


PICTORIAL VIEW



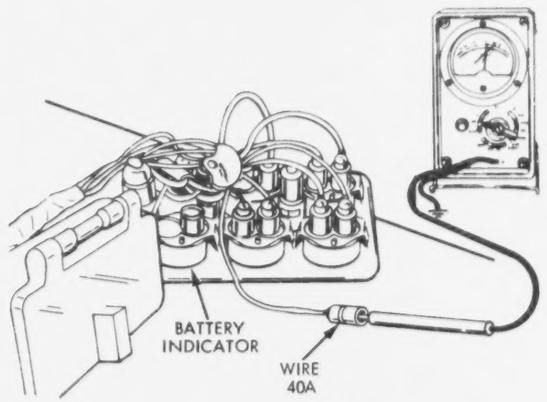
ELECTRICAL DIAGRAM

TA472057



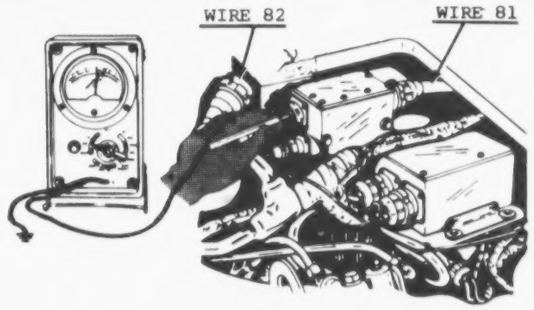
A Start engine and check air cleaner blower motors motors for operation. If inoperative, troubleshoot and repair air cleaner blower motor circuit (ref. p. 3-38). If air cleaner blower motors operate, go to step B.

B With engine running at 1000 rpm. Using multimeter, place red lead on battery positive terminal and ground black lead. If multimeter indicates approximately 27.5 volts or higher, go to step C. If voltage is lower than 27.5 volts, go to step I.

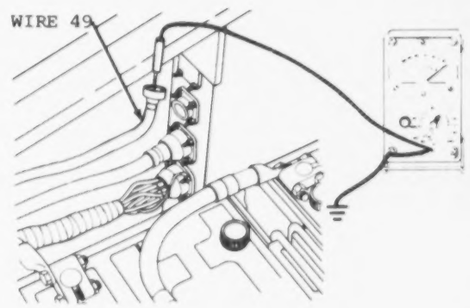


C Disconnect wire 40A from BATTERY indicator. Turn MASTER switch ON and check for voltage by placing red lead of multimeter in wire 40A and black lead to ground. If voltage is present, replace indicator (ref. p. 8-22). If voltage is not present, go to step D.

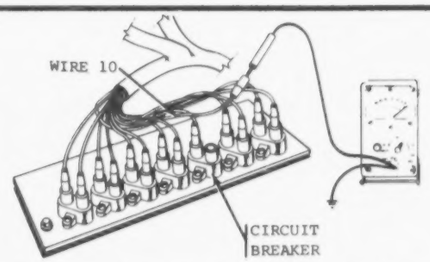
TA472058



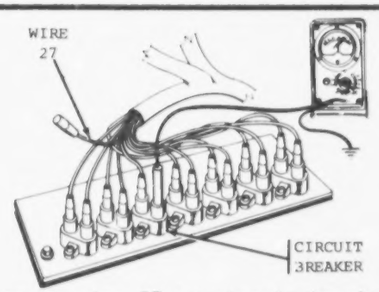
D Check wire 81 for breaks, cuts, and corroded terminals. Replace if necessary. Disconnect wire 82 from master relay. Turn MASTER switch ON. Place red multimeter lead in master relay and ground black lead. Check voltage. If no voltage, replace master relay (ref. p. 8-58). If voltage is present, reconnect and go to step E.



E Disconnect wire 49 at bulkhead disconnect. Turn MASTER switch ON. Place red multimeter 1 voltage by placing red lead of multimeter in wire 40A and black lead to ground. If voltage is present, replace indicator (ref. p. 8-25). If voltage is not present, go to step D.

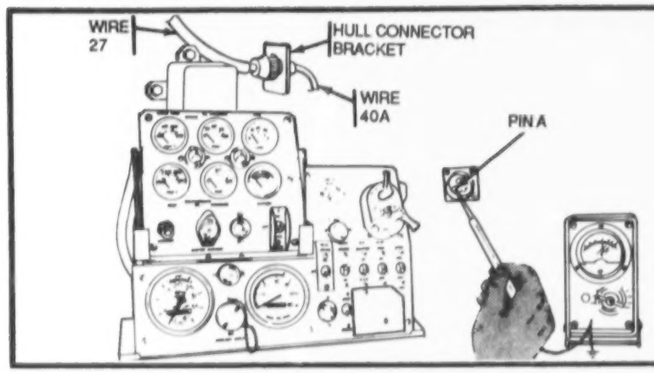


F Disconnect wire 10 to circuit breaker. Turn MASTER switch ON. Place red multimeter lead in wire 10 and black lead to ground. Check for voltage. If voltage is not present, replace wire 49 from master relay to bulkhead. If voltage is present, reconnect and go to step G.



G Disconnect wire 27 at circuit breaker. Turn MASTER switch ON. Place red lead of multimeter in circuit breaker output. Check for voltage. If voltage is not present, replace circuit breaker. If voltage is present, go to step H.

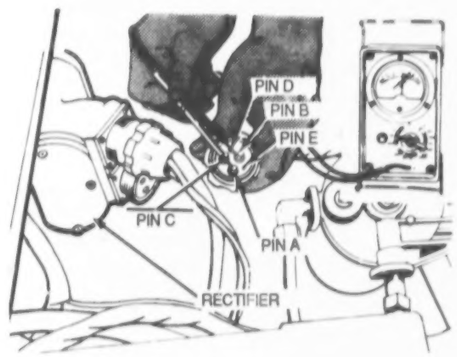
TA472059



H Disconnect harness at hull connector bracket on bulkhead next to driver connector bracket. Turn MASTER switch ON. Place red lead of multimeter on pin A black lead to ground. Check for voltage. If voltage is present, repair or replace wire 40A. If voltage is not present, repair or replace wire 27.

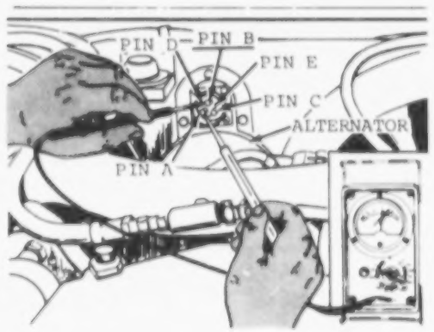
NOTE

For steps I, J, K, and L, use jumper wires with alligator clips.

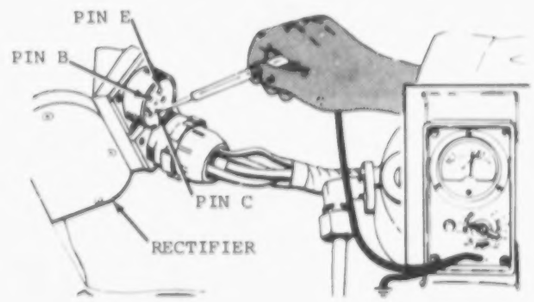


I Disconnect the alternator-to-rectifier harness at the rectifier. With jumper wires, connect pin E of the harness connector to a battery negative terminal and pin D of the connector to the positive terminal of the same battery to apply 12 volts dc to the alternator field. With the engine running at idle speed and the multimeter set on the ac volts scale, place red lead on pin A and black lead on pin B and note voltage reading. Then place red lead on pin C and black lead on pin A and note reading. All readings should be between 30 and 34 volts. If these voltages are present, reconnect harness and go to step K. If these voltages are not present or vary considerably, go to step J.

TA472060

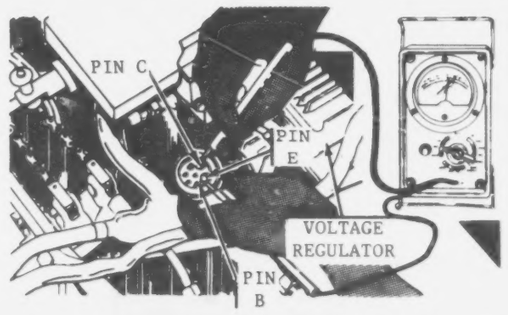


J Disconnect harness at alternator. With jumper wires, connect pin E of alternator to a battery negative terminal and pin D of alternator to the same battery positive terminal to apply 12 volts dc to the alternator field. Run vehicle engine at idle speed, set multimeter on ac volts scale, place red lead on pin A and negative lead on pin B, and note voltage reading. Then place red lead on pin C and black lead on pin A and note voltage reading. All readings should be between 30 and 34 volts. If these voltages are present, repair or replace cable from alternator to rectifier (ref. p. 8-70). If these voltages are not present or vary considerably, replace alternator (ref. p. 8-5).

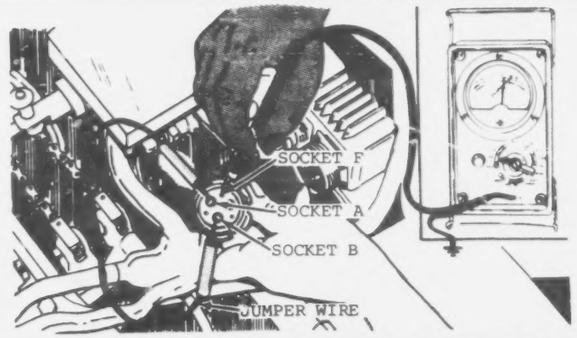


K Disconnect rectifier-to-regulator harness at rectifier. With jumper wires, connect pin E of rectifier to a battery negative terminal and pin B of harness to same battery positive terminal. With vehicle engine running at idle speed and multimeter set on the dc volts scale, place red lead on rectifier pin C and black lead to ground. Multimeter reading should be between 30 and 34 volts. If this voltage is not present, replace rectifier (ref. p. 8-8). If this voltage is present, reconnect harness and go to step L.

TA472061



L Disconnect rectifier-to-regulator harness at voltage regulator. With jumper wires, connect pin E of harness to a battery negative terminal and pin B of harness to positive terminal of the same battery. With vehicle engine running at idle speed and multimeter set on the dc volts scale, place red lead on pin C of harness and black lead to ground. Multimeter reading should be between 30 and 34 volts. If this voltage is not present, repair or replace rectifier-to-regulator harness (ref. p. 114). If this voltage is present, go to step M.

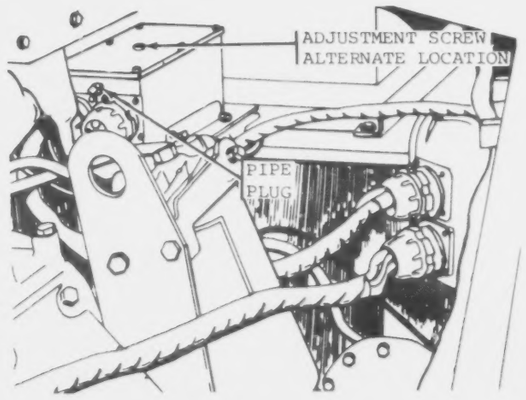


M Master switch OFF. Disconnect voltage regulator to bulkhead harness at voltage regulator. Use a jumper wire to connect socket A to socket B. Place master switch to ON position and start engine. Run engine at 1000 RPM (oil pressure 12 psi). Place red lead of multimeter in socket F and black lead to ground. If voltage is 24 vdc, troubleshoot air cleaner blower motor circuit (ref. p. 3-38).

NOTE

Batteries can be totally discharged within 4 to 6 hours if air cleaner blower motor system is malfunctioning or if blower motors operate full time. Troubleshooting step M provides a basic test of the blower motor circuit by testing the blower motor relay output voltage to the voltage regulator (wire 27B). If the blower motor relay output is 24 vdc (battery power) with the voltage regulator disconnected from the circuit, then the voltage regulator is malfunctioning/inoperative and will not charge the battery. If voltage is less than 24 vdc (battery power), then the blower motor circuit is malfunctioning and discharging the battery.

TA472062



CAUTION

Extremely low battery electrolyte levels will cause a low voltage indication on the BATTERY indicator on portable instrument panel. Regulators can be damaged by attempts to adjust the rheostat beyond its stops when the only problem is dry batteries.

N Do not check or adjust voltage regulator except as follows:

(1) Make sure batteries are fully charged while checking and/or adjusting regulator (ref. TM 9-2350-311-10).

(2) Connect red multimeter lead to the positive battery cable terminal and black lead to negative battery cable terminal.

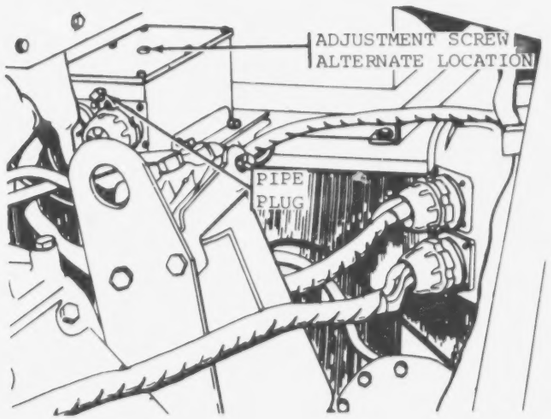
(3) Start engine and run at approximately 1000 rpm. Run engine as required to bring engine compartment, regulator, and batteries to normal operating temperature.

(4) During above warmup period, increase engine speed to approximately 2500 rpm and then return to idle speed while observing multimeter. Voltage reading should not vary more than +0.1 volt during above check. This also provides a check on tightness of wiring connection. Turn headlights on and off several times. Multimeter needle may vary slightly, but should return to its original (voltage) quickly.

(5) Turn off all major vehicle electrical components and turn on vehicle headlights.

(6) Open transmission left access door and remove square head pipe plug from end of voltage regulator (between and above harness connectors).

TA472063



CAUTION

Rheostat turns easily. Do not force beyond the stops.

(7) With engine running at 1000 rpm, use a screwdriver to adjust rheostat to obtain a voltage reading of 27.5 to 28.5 volts. Turn screwdriver counterclockwise to reduce voltage. Slowly turn screwdriver clockwise to bring regulated voltage up to 27.5 to 28.5 volts.

(8) Replace plug in end of regulator (screw on top of regulator).

(9) Shut off engine and remove multimeter.

(10) If regulator cannot be adjusted, replace regulator (ref. p. 8-7).

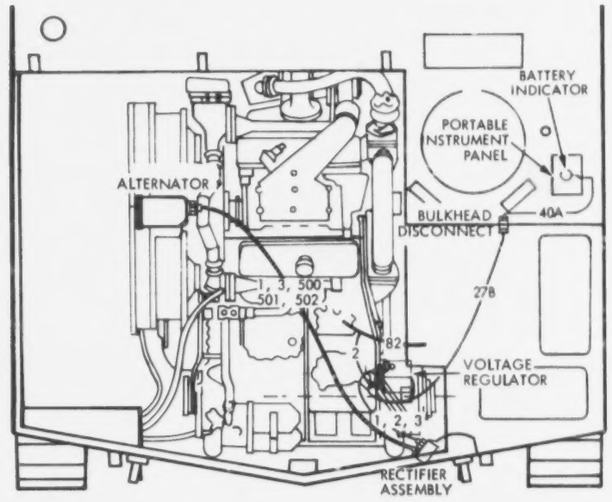
(11) If electrical (battery) problems continue after the regulator has been properly checked and/or adjusted, check the service, maintenance, and/or usage of the battery TM 9-6140-200-14.

TA472064

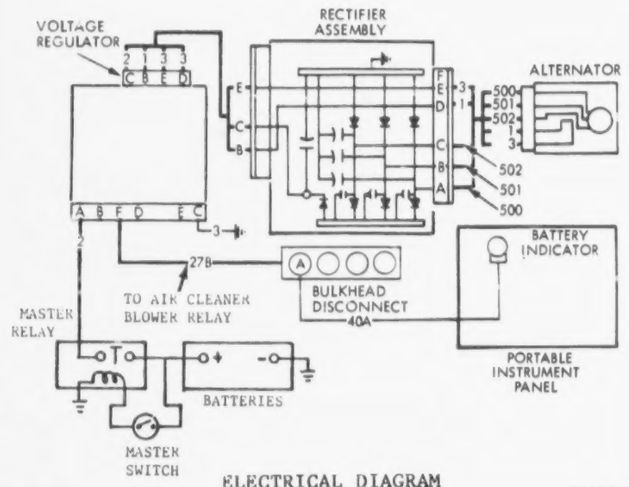
ALTERNATOR (M109A3 only)	CHARGING SYSTEM DOESN'T OPERATE. Do steps A through J. Gage shows not charging (in left red or yellow) with engine running or isn't steady or accurate. BATTERY IS OVERCHARGING. Do step K. BATTERY gage is in right red.

Troubleshoot charging system circuit.

CHARGING SYSTEM CIRCUIT

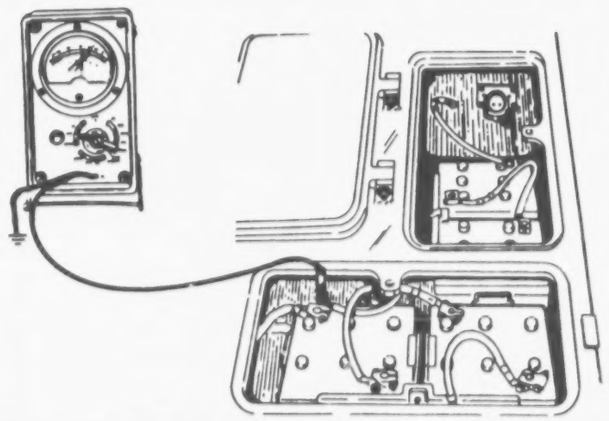


PICTORIAL VIEW



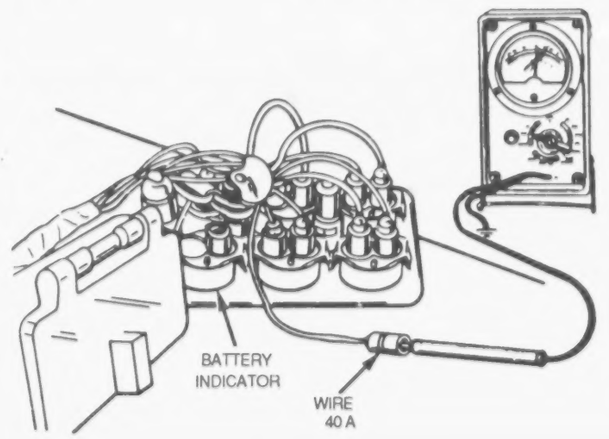
ELECTRICAL DIAGRAM

TA472065



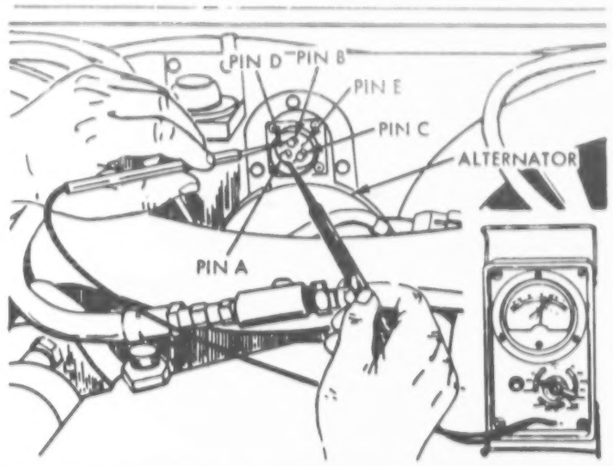
A Start engine and check air cleaner blower motors for operation. If inoperative, troubleshoot and repair air cleaner blower motor circuit (p. 3-38). If air cleaner blower motors operate, go to step B.

B With engine running at 1000 rpm. Using multimeter, place red lead on battery positive terminal and ground black lead. If multimeter indicates approximately 27.5 volts or higher, stop engine and go to step C. If voltage is lower than 27.5 volts, stop engine and go to step D.

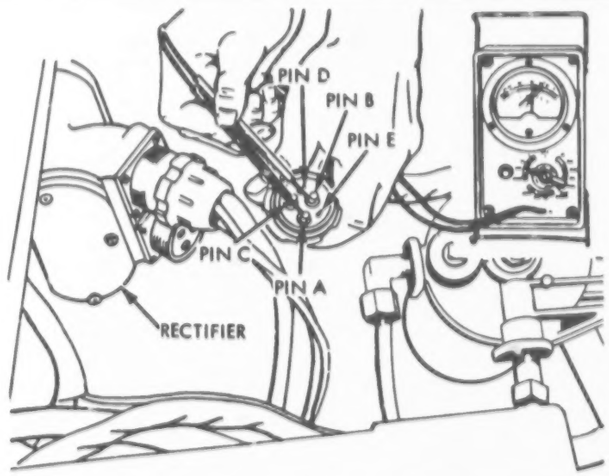


C Disconnect wire 40A from BATTERY indicator, start engine, and check for voltage by placing red lead of multimeter in wire 40A and black lead to ground. If voltage is present, stop engine and replace indicator (p. 8-22). If voltage is not present, stop engine and repair or replace wire 40A (p. 8-106).

TA472066

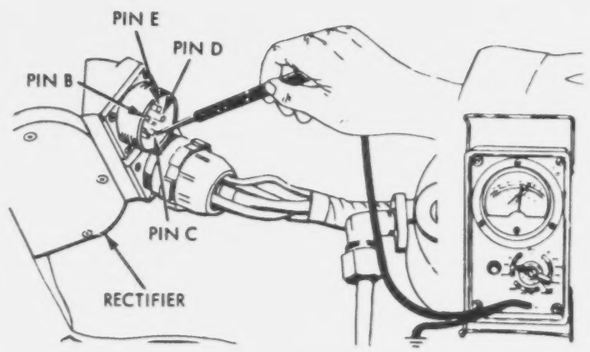


D Disconnect harness at alternator. With jumper wires, connect pin E of alternator to a battery negative terminal and pin D of alternator to the same battery positive terminal to apply 12 volts dc to the alternator field. Run vehicle engine at idle speed, set multimeter on ac volts scale, place red lead on pin A and negative lead on pin B, and note voltage reading. Place red lead on pin B and black lead on pin C and note voltage reading. Then place red lead on pin C and black lead on pin A and note voltage reading. All readings should be between 30 and 34 volts. If these voltages are present, stop engine and go to step E. If these voltages are not present or vary considerably, stop engine, replace alternator (ref. p. 8-5) and reconnect harness.

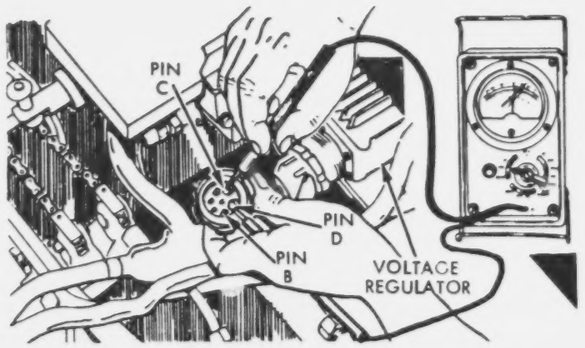


E Disconnect the alternator-to-rectifier harness at the rectifier. With jumper wires, connect pin E of the harness connector to a battery negative terminal and pin D of the connector to the positive terminal of the same battery to apply 12 volts dc to the alternator field. With the engine running at idle speed and the multimeter set on the ac volts scale, place red lead on pin A and black lead on pin B and note voltage reading. Place red lead on pin B and black lead on pin C and note reading. Then place red lead on pin C and black lead on pin A and note reading. All readings should be between 30 and 34 volts. If these voltages are present, stop engine, reconnect harness and go to step F.

TA472067



F Disconnect rectifier-to-regulator harness at rectifier. With jumper wires, connect pin E of rectifier to a battery negative terminal and pin B of harness to same battery positive terminal to apply 12 volts dc. With vehicle engine running at idle speed and multimeter set on the dc volts scale, place red lead on rectifier pin C and black lead on rectifier pin D (for hull-mounted rectifier, ground black lead to hull). Multimeter reading should be between 30 and 34 volts. If this voltage is not present, replace rectifier (ref. p. 8-8). If this voltage is present, stop engine, reconnect harness and go to step G.



G Disconnect rectifier-to-regulator harness at voltage regulator. With jumper wires, connect pin D of harness to a battery negative terminal and pin B of harness to positive terminal of the same battery to apply 12 volts dc. With vehicle engine running at idle speed and multimeter set on the dc volts scale, place red lead on pin C of harness and black lead on pin D of harness (for hull-mounted rectifier, ground black lead). Multimeter reading should be between 30 and 34 volts dc. If this voltage is not present, stop engine, repair or replace rectifier-to-regulator harness (ref. p. 8-114). If this voltage is present, go to step H.

TA472068

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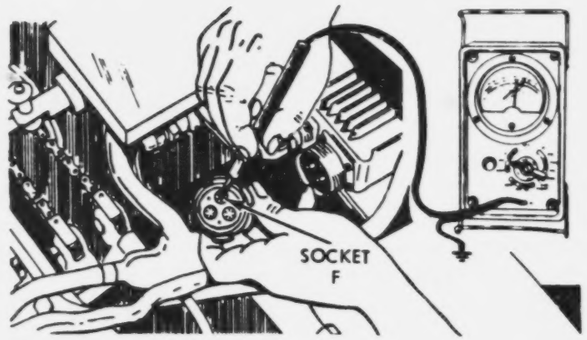
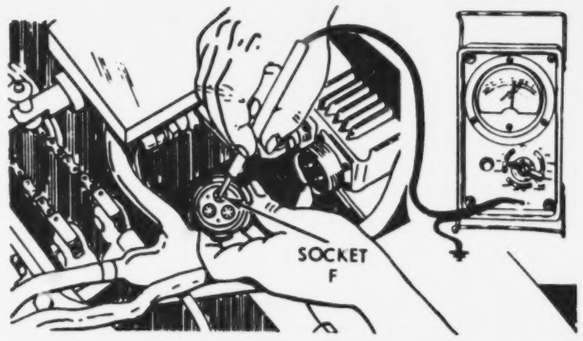
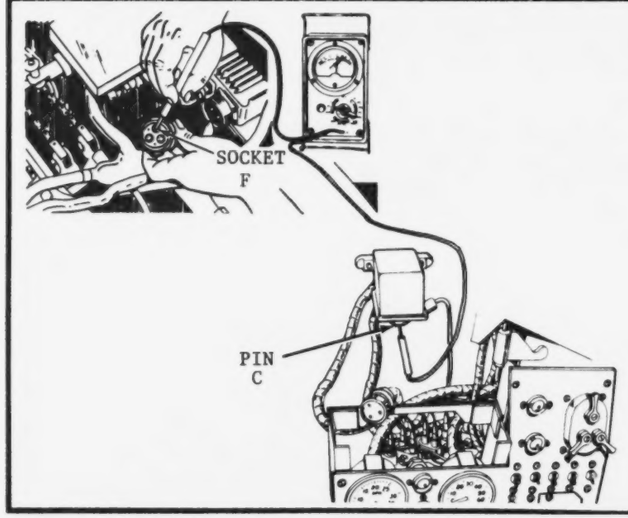


H Disconnect voltage regulator-to-bulkhead harness at the voltage regulator. With jumper wires, connect pin C of voltage regulator to battery negative terminal and pin F of voltage regulator to battery positive terminal to apply 24 volts dc to voltage regulator input. With the engine running at idle speed, check voltage at pin A of voltage regulator by placing red lead of multimeter on pin A and black lead of multimeter on pin C of voltage regulator. Reading should be 27.5 volts plus or minus 0.5 volts. If this voltage is not present, replace voltage regulator (ref. p. 8-7). If voltage is present, turn off engine, disconnect jumper wires from battery terminals and go to step I.

TA472069

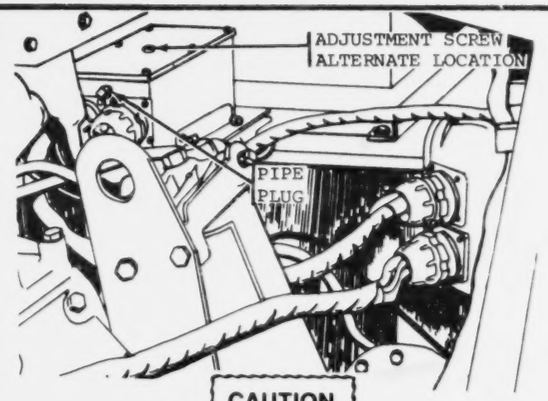


I With the vehicle shut down, place red multimeter lead in Socket F of regulator-to-bulkhead harness and black lead to ground. Multimeter should read 0 volts. Start vehicle engine and observe multimeter. Reading should be 24 volts. If this voltage is not present, stop engine and go to step J.



J Disconnect connector at air cleaner blower relay. Check continuity of 27B circuit between Socket F of bulkhead-to-regulator harness and Pin C of air cleaner blower relay connector. If continuity is not present, remove and replace as necessary (refer to Schematic page FO-1).

TA472070



CAUTION

Extremely low battery electrolyte levels will cause a low voltage indication on the BATTERY indicator on portable instrument panel. Regulators can be damaged by attempts to adjust the rheostat beyond its stops when the only problem is dry batteries.

K Do not check or adjust voltage regulator except as follows:

(1) Make sure batteries are fully charged while checking and/or adjusting regulator (ref. TM 9-2350-311-10).

(2) Connect red multimeter lead to the positive battery cable terminal and black lead to negative battery cable terminal.

(3) Start engine and run at approximately 1000 rpm. Run engine as required to bring compartment, regulator, and batteries to normal operating temperature.

(4) During above warmup period, increase engine speed to approximately 2500 rpm and then return to idle speed while observing multimeter. Voltage reading should not vary more than +0.1 volt during above check. This also provides a check on tightness of wiring connection. Turn headlights on and off several times. Multimeter needle may vary slightly, but should return to its original position (voltage) quickly.

(5) Turn off all major vehicle electrical components and turn on vehicle headlights.

(6) Open transmission left access door and remove square head pipe plug from end of voltage regulator (between and above harness connectors).

CAUTION

Rheostat turns easily. Do not force rheostat beyond the stops.

(7) With engine running at 1000 rpm, use a screwdriver to adjust rheostat to obtain a voltage reading of 27.3 to 27.5 volts. Turn screwdriver counterclockwise to reduce voltage. Slowly turn screwdriver clockwise to bring regulated voltage up to 27.3 to 27.5 volts.

(8) Replace plug in end of regulator.

(9) Repeat step (4). If this check is satisfactory, shut off engine and remove multimeter.

(10) If regulator cannot be adjusted, replace regulator and/or adjust the new regulator (ref. p. 8-7).

(11) If electrical (battery) problems continue after the regulator has been properly checked and/or adjusted, check the service, maintenance and/or usage of the battery (ref. TM 9-6140-200-12).

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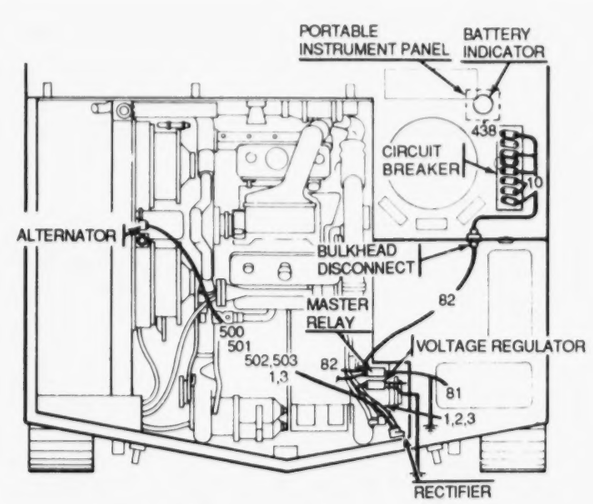
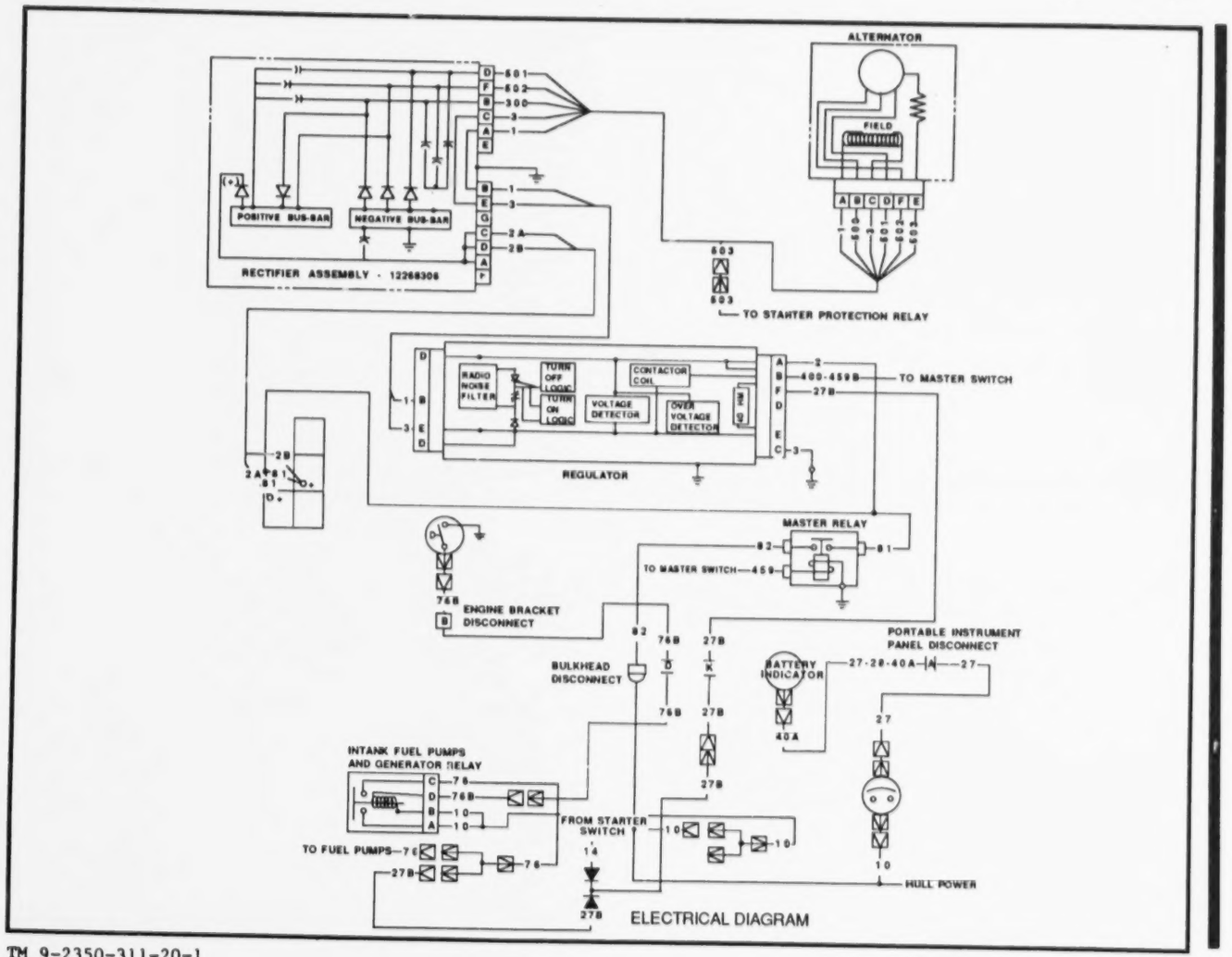
ALTERNATOR (M109A4 ONLY)	CHARGING SYSTEM DOESN'T OPERATE. Do steps A through J. Gage shows not charging with engine running or isn't steady or accurate. BATTERY IS OVERCHARGING. Do step K, only if vehicle is equipped with an adjustable regulator. If not, replace regulator (ref. p. 8-7).

Troubleshoot charging system circuit.

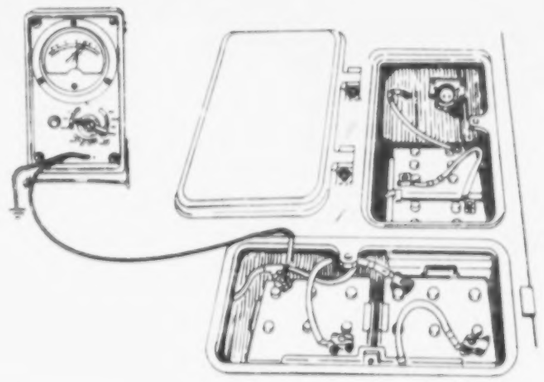
M109A4 CHARGING SYSTEM CIRCUIT



PICTORIAL VIEW

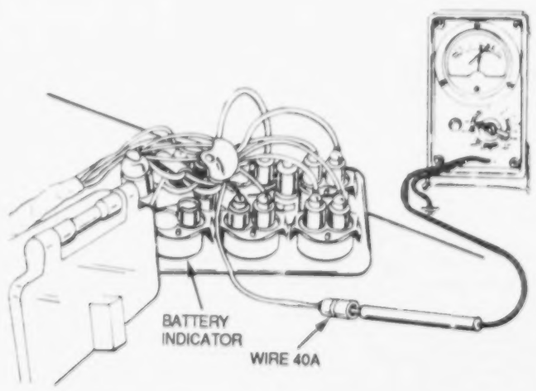


ELECTRICAL DIAGRAM

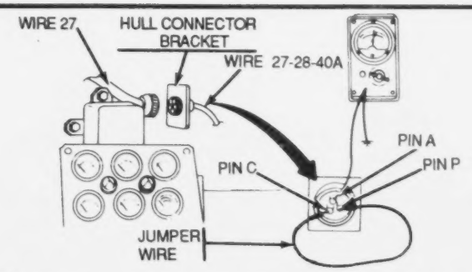


A Start engine and check in-tank fuel pumps for operacion. If inoperative, troubleshoot and repair in-tank fuel pump circuit (ref. p. 3-106.1). If in-tank fuel pumps operate, go to step B.

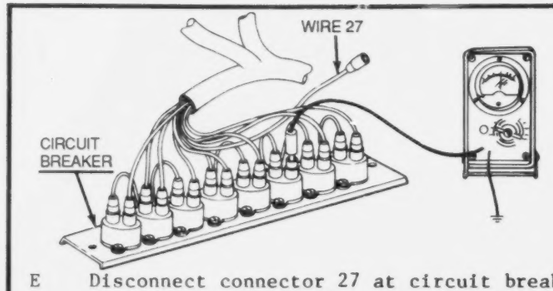
B With engine running at 1000 rpm, using multimeter, place red lead on battery positive terminal and ground black lead. If multimeter indicates approximately 27.5 volts or higher, go to step C. If voltage is lower than 27.5 volts, go to step G.



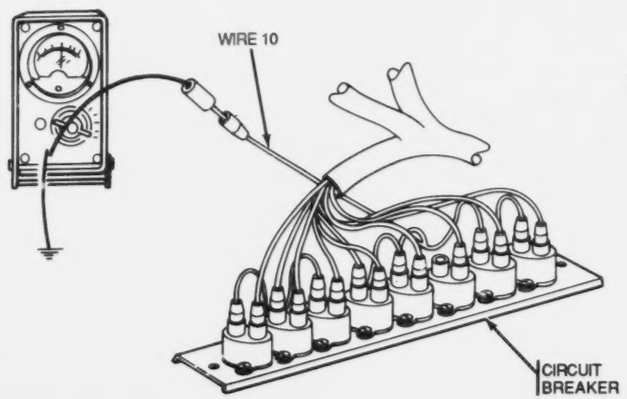
C Disconnect wire 40A from BATTERY indicator. Turn MASTER switch ON and check for voltage by placing red lead of multimeter in wire 40A and black lead to ground. If voltage is present, replace indicator (ref. p. 8-22). If voltage is not present, go to step D.



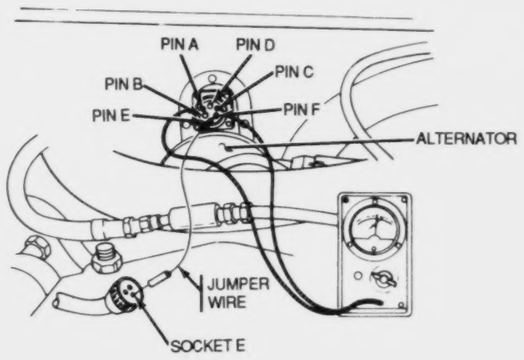
D Disconnect connector at portable instrument panel wiring harness bracket. Place jumper wire between pins P and C. Place red multimeter lead on pin A and black lead to ground. Check for voltage. If voltage is present, repair or replace wire 27-28-40A to battery indicator (ref p. 8-106.4). If voltage is not present, go to step E.



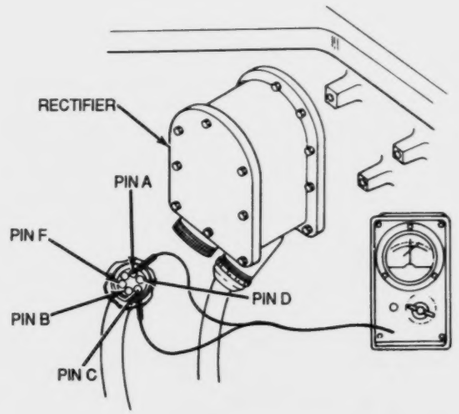
E Disconnect connector 27 at circuit breaker. With MASTER switch ON, place red multimeter lead in circuit breaker output and black to ground. Check for voltage. If voltage is present, repair or replace wire 27 to portable instrument panel (ref. p. 8-84). If voltage is not present, go to step F.



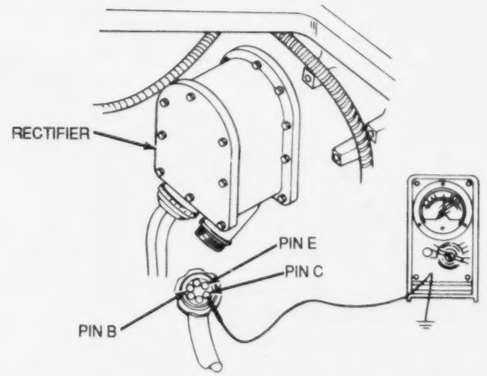
F Disconnect connector 10 at circuit breaker. With MASTER switch ON, place red multimeter lead in connector, wire 10, and black to ground. Check for voltage. If voltage is present, replace circuit breaker (ref. p. 8-64). If voltage is not present, repair or replace wire 10 (ref. p. 8-106).



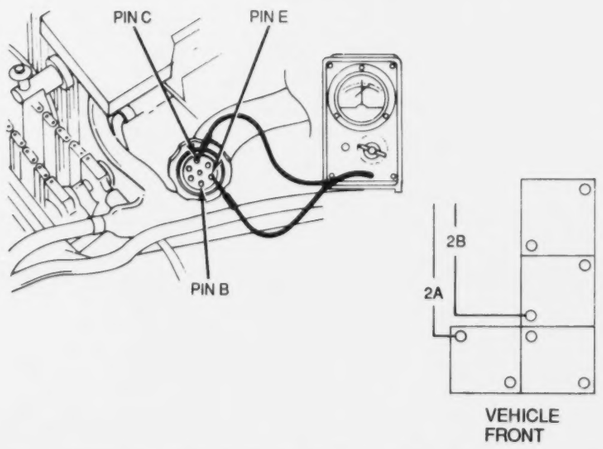
G Disconnect harness at alternator. Using jumper wires with alligator clips, connect pin C of alternator to a battery negative terminal and pin A of alternator to the positive terminal of same battery to apply 12 volts dc to the alternator field. Connect pin E of alternator to socket E of harness. Run vehicle engine at 1000 RPM, set multimeter on ac volts scale, place red lead on pin B and negative lead on pin D, and note voltage reading. Then place red lead on pin F and black lead on pin B and note voltage reading. All readings should be between 30 and 34 volts. If these voltages are present go to step H. If these voltages are not present or vary considerably, replace alternator (ref. p. 8-5).



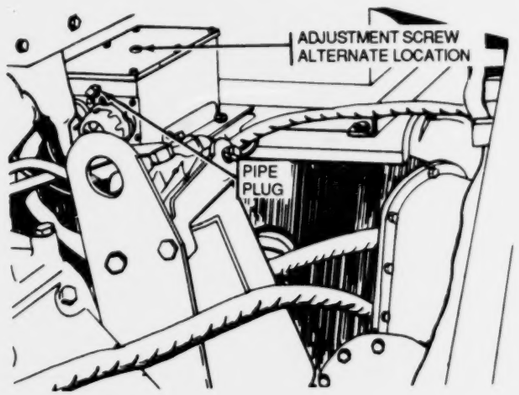
H Disconnect the alternator-to-rectifier cable of powerplant wiring harness at the rectifier. Using jumper wires with alligator clips connect pin C of the harness connector to a battery negative terminal and pin A of the connector to the positive terminal of the same battery to apply 12 volts dc to the alternator field. With the engine running at 1000 RPM and the multimeter set on the ac volts scale, place red lead on pin B and black lead on pin D and note voltage reading. Then place red lead on pin F and black lead on pin B and note reading. All readings should be between 30 and 34 volts. If these voltages are present, reconnect harness and go to step I. If these voltages are not present or vary considerably, repair or replace alternator-to-rectifier cable of powerplant wiring harness (ref. p. 8-74).



I Disconnect rectifier-to-regulator wiring harness at rectifier. Using jumper wires with alligator clips, connect pin E of rectifier to a battery negative terminal and pin B of rectifier to same battery positive terminal. With vehicle engine running at 1000 RPM and multimeter set on the dc volts scale, place red lead on rectifier pin C and black lead to ground. Multimeter reading should be between 40 and 45 volts. If this voltage is not present, replace rectifier (ref. p. 8-10). If this voltage is present, reconnect harness and go to step J.



J Disconnect rectifier-to-regulator wiring harness at voltage regulator. Using jumper wires with alligator clips, connect pin E of harness to a battery negative terminal and pin B of harness to positive terminal of the same battery. Disconnect wire 2A at battery positive terminal. With vehicle engine running at 1000 RPM and multimeter set on the dc volts scale, place red lead on wire 2A and black lead to ground. Multimeter reading should be between 40 and 45 volts. If this voltage is not present, repair or replace rectifier-to-regulator wiring harness (ref. p. 8-116). If this voltage is present, replace regulator (ref. p. 8-7).



CAUTION

Extremely low battery electrolyte levels will cause a low voltage indication on the BATTERY indicator on portable instrument panel. Regulators can be damaged by attempts to adjust the rheostat beyond its stops when the only problem is dry batteries.

K Do not check or adjust voltage regulator except as follows:

(1) Make sure batteries are fully charged while checking and/or adjusting regulator (ref. TM 9-2350-311-10).

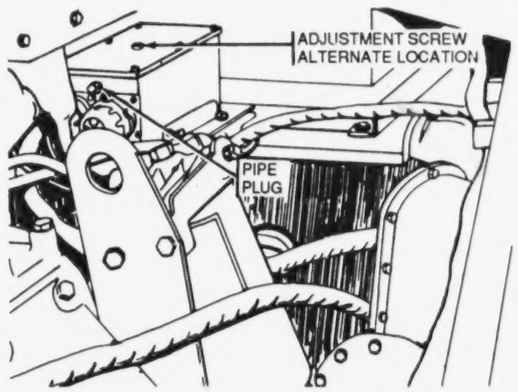
(2) Connect red multimeter lead to the positive battery cable terminal and black lead to negative battery cable terminal.

(3) Start engine and run at approximately 1000 rpm. Run engine as required to bring engine compartment, regulator, and batteries to normal operating temperature.

(4) During above warmup period, increase engine speed to approximately 2500 rpm and then return to idle speed while observing multimeter. Voltage reading should not vary more than +0.1 volt during above check. This also provides a check on tightness of wiring connection. Turn headlights on and off several times. Multimeter needle may vary slightly, but should return to its original (voltage) quickly.

(5) Turn off all major vehicle electrical components and turn on vehicle headlights.

(6) Open transmission left access door and remove square head pipe plug from end of voltage regulator (between and above harness connectors).



CAUTION

Rheostat turns easily. Do not force beyond the stops.

(7) With engine running at 1000 rpm, use a screwdriver to adjust rheostat to obtain a voltage reading of 27.5 to 28.5 volts. Turn screwdriver counterclockwise to reduce voltage. Slowly turn screwdriver clockwise to bring regulated voltage up to 27.5 to 28.5 volts.

(8) Replace plug in end of regulator (screw) on top of regulator).

(9) Turn off vehicle headlights.

(10) Shut off engine and remove multimeter.

(11) If regulator cannot be adjusted, replace regulator (ref. p. 8-7).

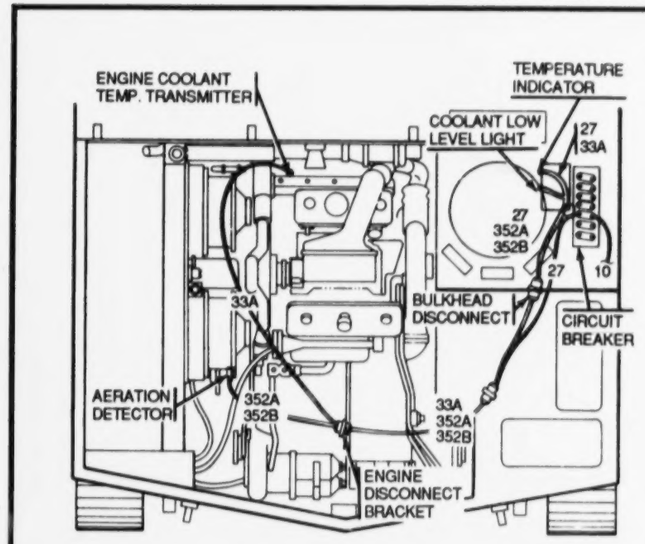
(12) If electrical (battery) problems continue after the regulator has been properlay checked and/or adjusted, check the service, maintenance, and/or usage of the battery TM 9-6140-200-14.

GAGES	Engine coolant temperature gage needle doesn't move or isn't steady or accurate. Do steps A through C. Engine low level coolant light doesn't light (when pressed to test). Do steps D through L. Or engine low level coolant light gives false indication of coolant level conditions. Do steps M through Q.

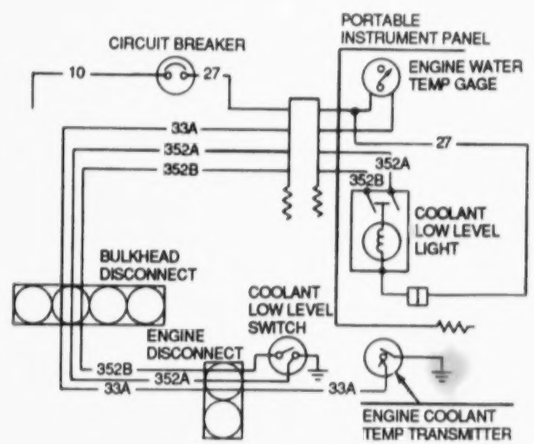
Troubleshoot engine coolant temperature (ENGINE WATER TEMP) indicator circuit.

Troubleshoot engine low level coolant (AERATION DETECTOR) CIRCUIT.

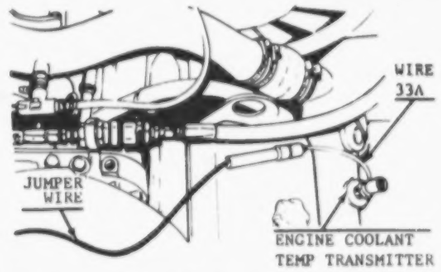
ENGINE COOLANT INDICATOR CIRCUITS.



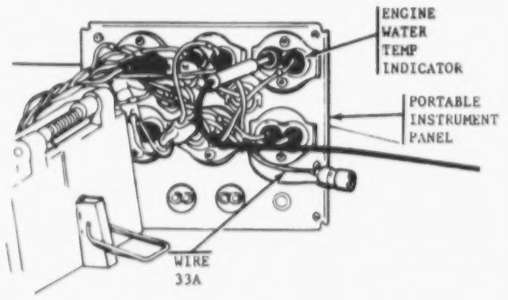
PICTORIAL VIEW



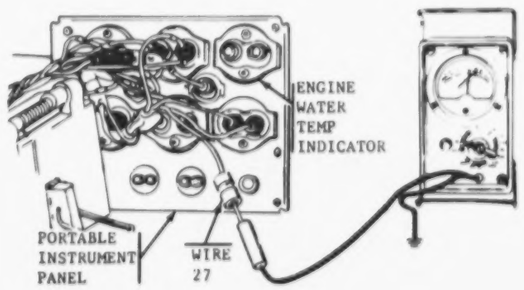
ELECTRICAL DIAGRAM



A Disconnect wire 33A from engine coolant temperature transmitter. Turn MASTER switch ON. After disconnecting, if ENGINE WATER TEMP indicator shows a minimum reading, use a jumper wire to ground wire 33A. After grounding, if indicator shows a maximum reading, replace engine coolant temperature transmitter (ref. p. 8-10.2). If indicator fails to show a minimum or maximum reading, go to step B.



B Disconnect wire 33A at ENGINE WATER TEMP indicator. Turn MASTER switch ON. If indicator shows a minimum reading, use a jumper wire to ground indicator. If indicator shows a maximum reading, repair or replace wire 33A from indicator to transmitter (ref. p. 8-106.4). If indicator fails to read correctly, go to step C.



C Disconnect wire 27 from ENGINE WATER TEMP indicator. Turn MASTER switch ON. Place red lead of multimeter in wire 27. Ground black lead and check for voltage. If voltage is present, replace ENGINE WATER TEMP indicator (ref. p. 8-22). If no voltage, repair to replace wire 27 (ref. p. 8-106.4). Reconnect all wires.

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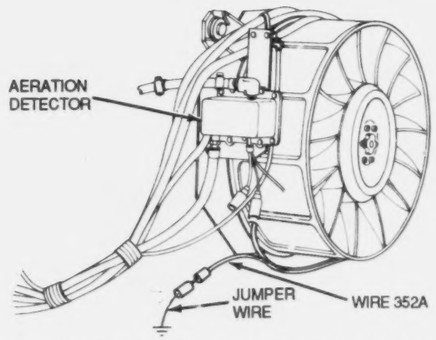
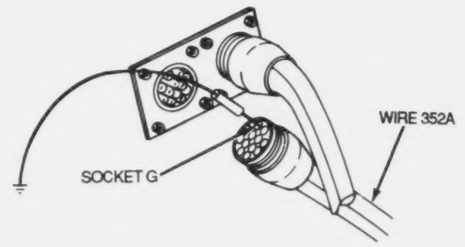
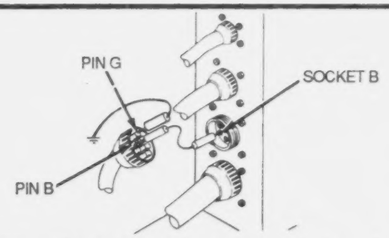


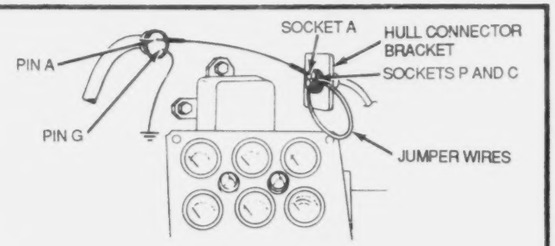
D Disconnect wire 352A at aeration detector. Turn MASTER switch ON. Use a jumper wire to connect 352A to ground. If indicator lamp lights when "pressed to test", replace aeration detector (ref. p. 8-20). If indicator lamp does not light, go to step E.



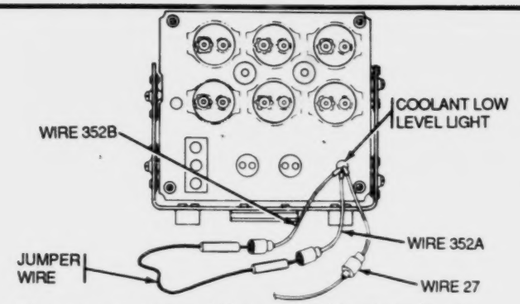
E With MASTER switch ON, disconnect bulkhead to engine bracket wiring harness at engine bracket. Use a jumper wire to ground wire 352A (socket G). If indicator lamp lights when "pressed to test", repair powerplant wiring harness (ref. p. 8-70). If indicator lamp does not light, go to step F.



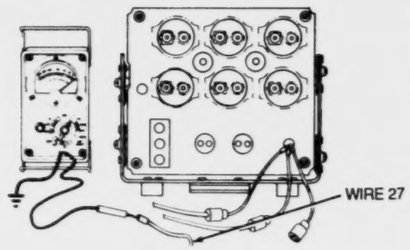
F With MASTER switch ON, disconnect driver's compartment bulkhead to portable instrument panel wiring harness. Using jumper wires, ground wire 352A (pin G) and connect pin and socket B (wire 400-459B). If indicator lamp lights when "pressed to test", repair engine disconnect bracket to bulkhead wiring harness (ref. p. 8-74.4). If indicator lamp fails to light, go to step G.



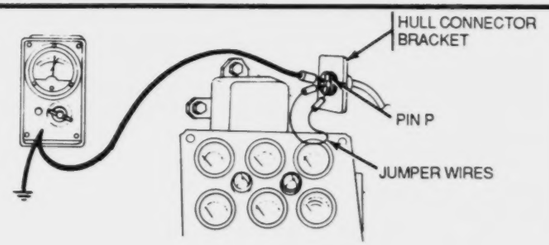
G Disconnect portable instrument panel wiring harness. Using jumper wires, connect socket A to pin A (wire 27) and wire 352A (pin G) to ground. Connect sockets P and C. If indicator lamp lights when "pressed to test", repa repair bulkhead to portable instrument panel wiring harness (ref. p. 8-84). If indicator lamp fails to light, go to step H.



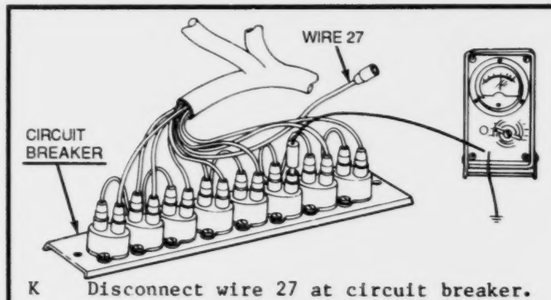
H Disconnect wire 352A at indicator lamp. With MASTER switch ON, ground lead 352A from indicator lamp using jumper wire. If indicator lamp lights when "pressed to test", repair or replace portable instrument panel wiring harness (ref. p. 8-106.4). If indicator lamp fails to light go to step I.



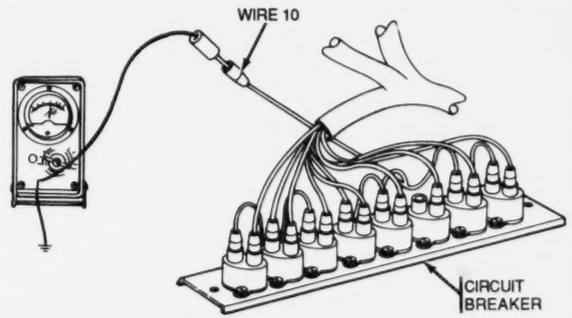
I With MASTER switch ON, disconnect wire 27 at indicator lamp. Place red multimeter lead in connector, wire 27 and black lead to ground. If voltage is present, replace indicator lamp (ref. p. 8-22). If voltage is not present, go to step J.



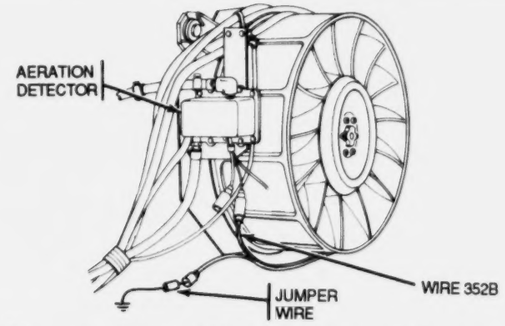
J Disconnect portable instrument panel wiring harness. Using jumper wires, connect pins P and C. Place red multimeter lead on pin A and check for voltage. If voltage is present, repair or replace portable instrument panel wiring harness (ref p. 8-106.4). If voltage is not present go to step K.



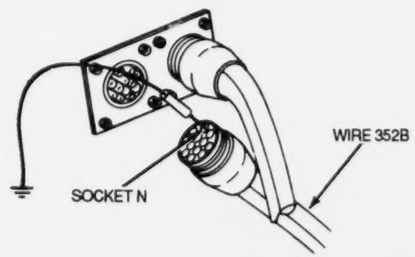
K Disconnect wire 27 at circuit breaker. With MASTER switch ON, place red multimeter lead in circuit breaker output and black to ground. Check for voltage. If voltage is present, repair bulkhead to portable instrument panel wiring harness (ref p. 8-84). If voltage is not present go to step L.



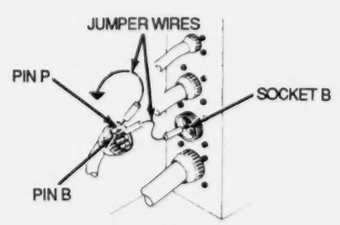
L Disconnect wire 10 at circuit breaker. With MASTER switch ON, place red multimeter lead in wire 10, and black to ground. If voltage is present, replace circuit breaker. If voltage is not present, repair power lead (ref p. 8-100 or 8-103).



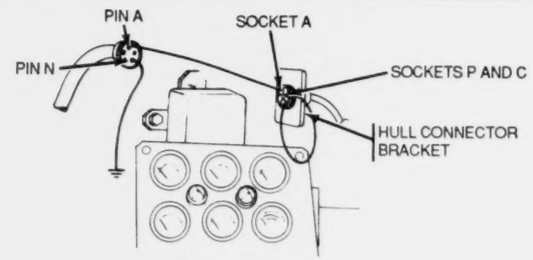
M Disconnect wire 352B at aeration detector. Using jumper wire ground wire 352B. With MASTER switch ON, check if indicator light is lit. If light is lit, replace aeration detector (ref p. 8-20). If indicator lamp is not lit, go to step N.



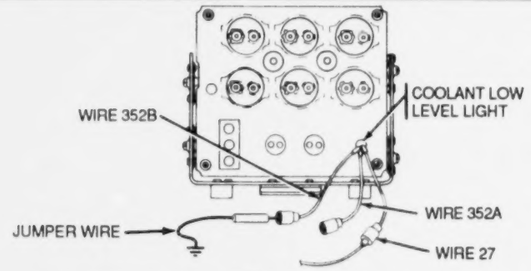
N With MASTER switch ON, disconnect bulkhead to engine bracket wiring harness at engine bracket. Use jumpwer wire to ground wire 352B (socket N). If indicator lamp lights, repair powerplant wiring harness (ref. p. 8-74). If indicator lamp does not light, go to step O.



O With MASTER switch ON, disconnect bulkhead to portable instrument panel wiring harness. Using jumper wires, ground wire 352B (pin P) and connect socket and pin B (wire 400-459B). If indicator lamp lights, repair engine disconnect bracket to bulkhead wiring harness (ref. p. 8-74.4) If indicator lamp fails to light, go to step P.



P Disconnect portable instrument panel wiring harness. Using jumper wires, connect socket A to pin A (wire 27) and wire 352B (pin N) to ground. Connect sockets P and C. If indicator lamp lights, repair bulkhead to portable instrument panel wiring harness (ref. p. 8-84). If indicator lamp fails to light, go to step Q.

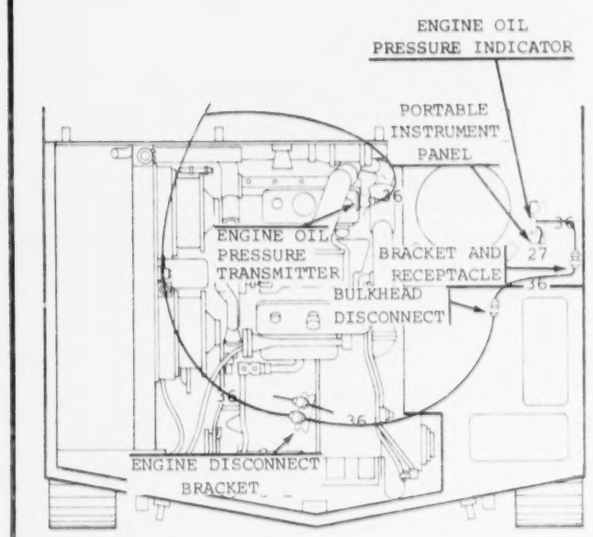


Q Disconnect wire 352B at indicator lamp. With MASTER switch ON, ground lead 352B from indicator lamp using jumper wire. If indicator lamp lights, repair or replace portable instrument panel wiring harness (ref. p. 8-106.4). If indicator lamp fails to light, replace indicator lamp (ref. p. 8-22).

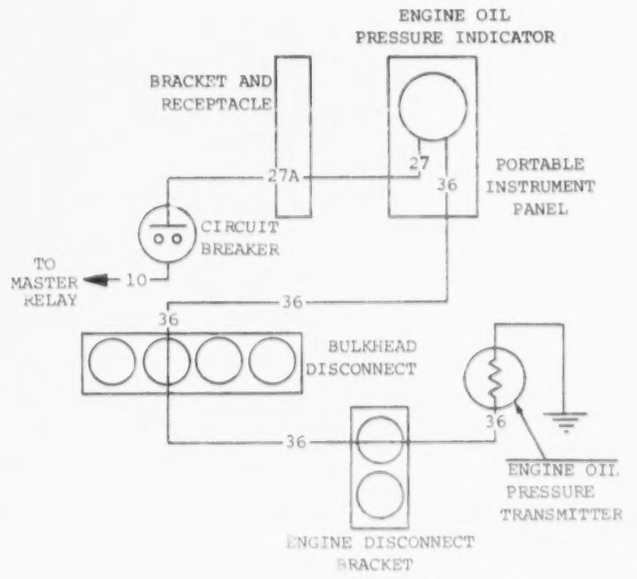
GAGES	ENGINE OIL PRESSURE GAGE NEEDLE DOESN'T MOVE OR ISN'T STEADY OR ACCURATE.

Troubleshoot ENGINE OIL PRESSURE indicator circuit.

ENGINE OIL PRESSURE INDICATOR CIRCUIT.

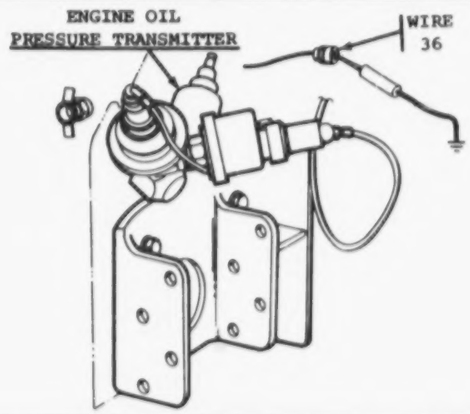


PICTORIAL VIEW

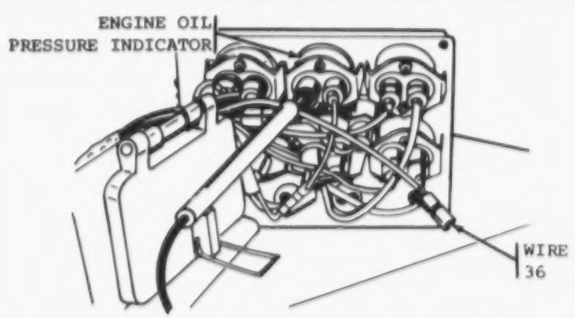


ELECTRICAL DIAGRAM

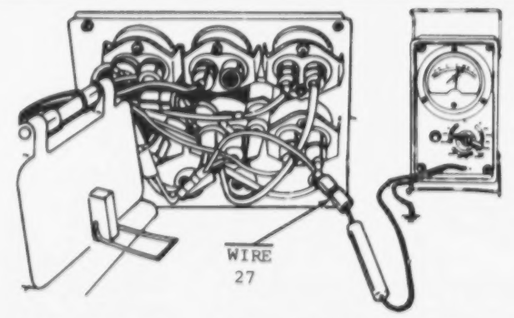
TA472075



A Disconnect wire 36 at engine oil pressure transmitter. Turn MASTER switch on. If ENGINE OIL PRESSURE indicator shows a maximum reading, use a jumper to ground wire 36. If indicator shows a minimum reading, replace engine oil pressure transmitter (ref. p. 8-12). If indicator fails to show a minimum or maximum reading, go to step B.



B Disconnect wire 36 at ENGINE OIL PRESSURE indicator. Turn MASTER switch ON. If indicator shows a maximum reading, use a jumper to ground indicator. If indicator shows a minimum reading, replace engine oil pressure transmitter (ref. p. 8-12). If indicator fails to show a minimum or maximum reading, go to step C.



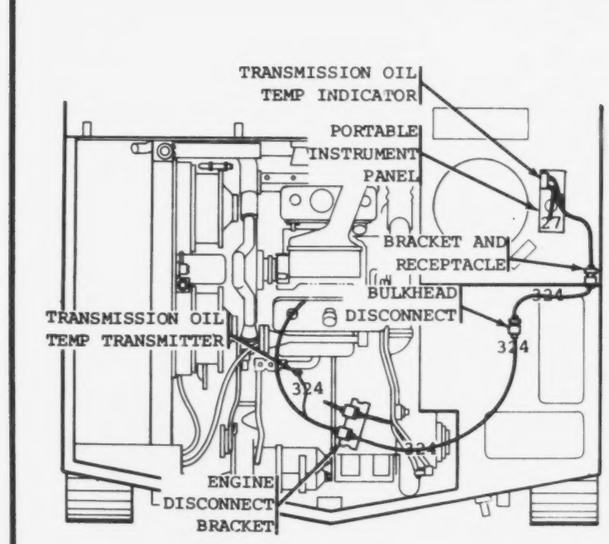
C Disconnect wire 27 from ENGINE OIL PRESSURE indicator. Turn MASTER switch ON. Place red multimeter lead in wire 27, ground black lead, and check for voltage. If voltage is present, replace ENGINE OIL PRESSURE indicator (ref. p. 8-22). If no voltage, repair or replace wire 27. Reconnect all wires.

TA472076

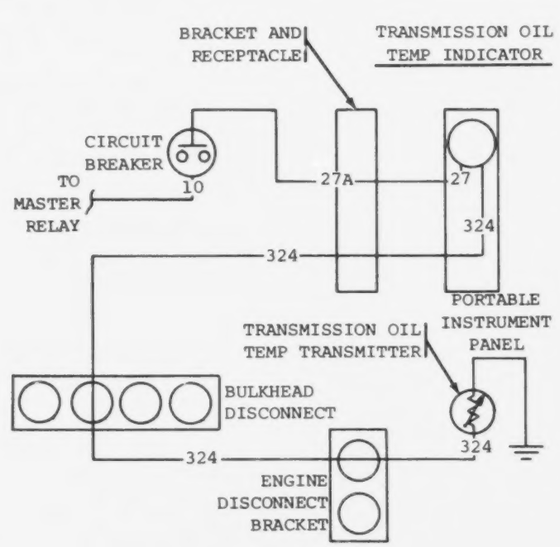
GAGES	TRANSMISSION OIL TEMPERATURE GAGE NEEDLE DOESN'T MOVE OR ISNT'T STEADY OR ACCURATE).

Troubleshoot transmission oil temperature (TRANSMISSION OIL TEMP) indicator circuit.

TRANSMISSION OIL TEMPERATURE INDICATOR CIRCUIT

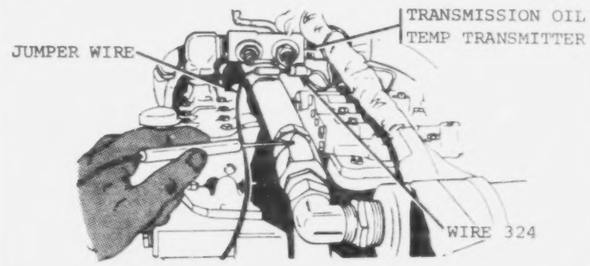


PICTORIAL VIEW

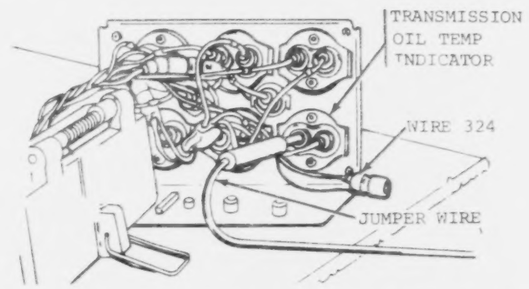


ELECTRICAL DIAGRAM

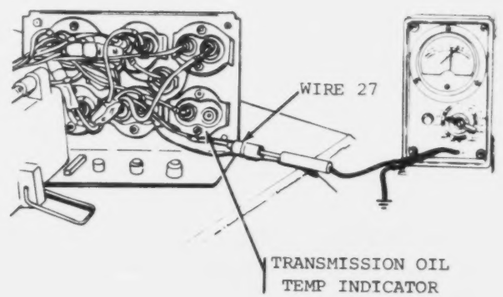
TA472077



A Disconnect wire 324 at transmission oil temperature transmitter. Turn MASTER switch ON. If TRANSMISSION OIL TEMP indicator shows a minimum reading, use a jumper wire to ground wire 324 at transmission oil temperature transmitter. If indicator shows maximum reading, replace transmission oil temperature transmitter (ref. p. 8-16). If indicator fails to show a minimum or maximum reading, go to step B.



B Disconnect wire 324 at TRANSMISSION OIL TEMP indicator. Turn MASTER switch ON. If indicator shows a minimum reading, use a jumper wire and ground indicator. If indicator shows a maximum reading, repair or replace wire 324 from indicator to transmission oil temperature transmitter (ref. p. 8-106). If indicator fails to show minimum or maximum reading, go to step C.



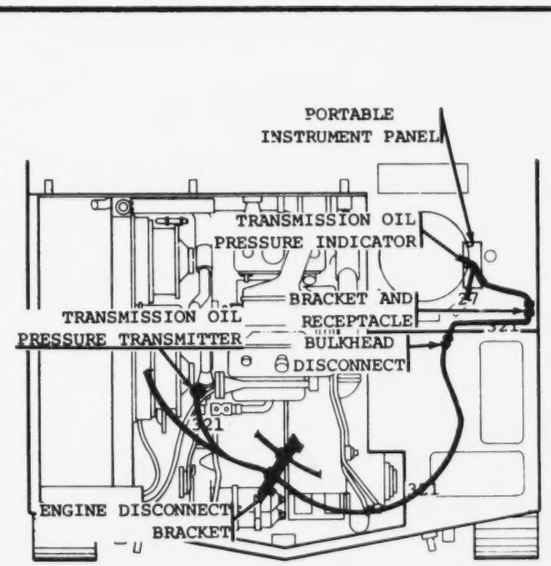
C Disconnect wire 27 from TRANSMISSION OIL TEMP indicator. Turn MASTER switch ON. Place red lead of multimeter in wire 27, ground black lead, and check for voltage. If voltage is present, replace TRANSMISSION OIL TEMP indicator (ref. p. 8-22). If no voltage, repair or replace wire 27 (ref. p. 8-106). Reconnect all wires.

TA472078

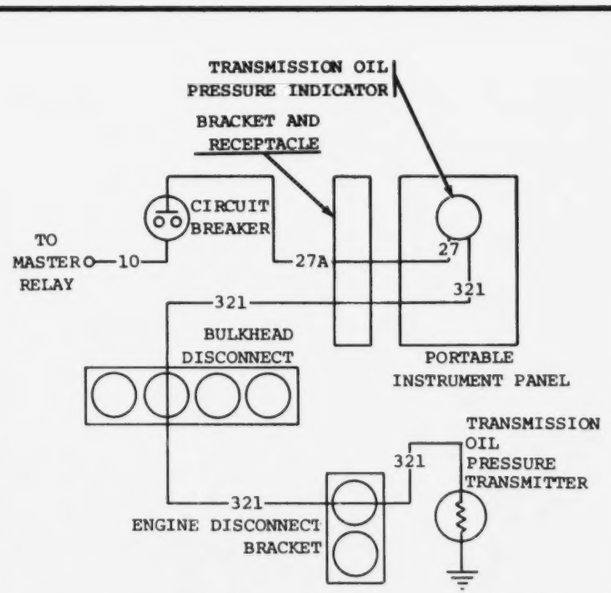
GAGES	TRANSMISSION OIL PRESSURE GAGE NEEDLE DOESN'T MOVE OR ISN'T STEADY OR ACCURATE.

Troubleshoot TRANSMISSION OIL PRESSURE indicator circuit.

TRANSMISSION OIL PRESSURE INDICATOR CIRCUIT

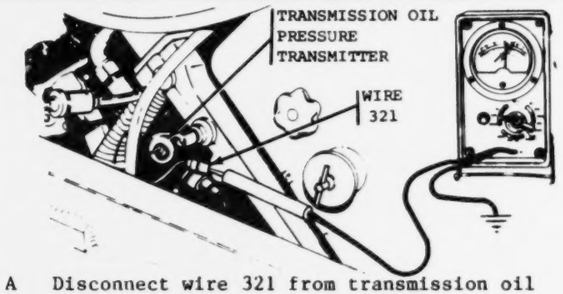


PICTORIAL VIEW

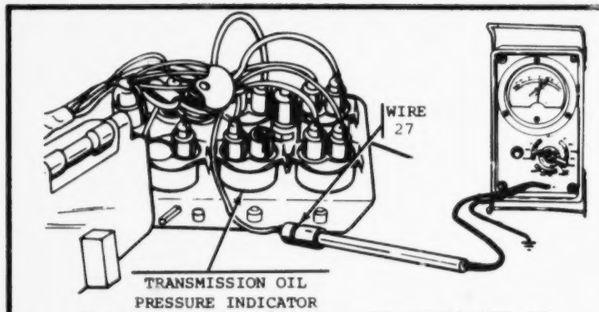


ELECTRICAL DIAGRAM

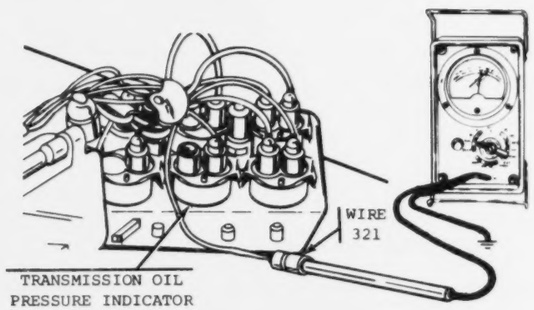
TA472079



A Disconnect wire 321 from transmission oil pressure transmitter. Turn MASTER switch ON. Check for proper grounding of transmitter. If TRANSMITTER OIL PRESSURE indicator shows a maximum reading, use a jumper to ground wire 321 at transmitter. If indicator shows a minimum reading, replace transmission oil pressure transmitter (ref. p. 8-16). If indicator fails to show a minimum or maximum reading, go to step B.



B Disconnect wire 321 from TRANSMISSION OIL PRESSURE indicator. Turn MASTER switch ON. If indicator shows a maximum reading, use a jumper wire to ground indicator. If indicator shows a minimum reading, repair or replace wire 321 from TRANSMISSION OIL PRESSURE indicator to transmission oil pressure transmitter (ref. p. 8-106). If indicator fails to show a minimum or maximum reading, go to step C.



C Disconnect wire 27 from TRANSMISSION OIL PRESSURE indicator. Place red multimeter lead in wire 27 and ground black lead. Check for voltage. If voltage is present, replace TRANSMISSION OIL PRESSURE indicator. If no voltage, repair or replace wire 27 (ref. p. 8-106). Reconnect all wires.

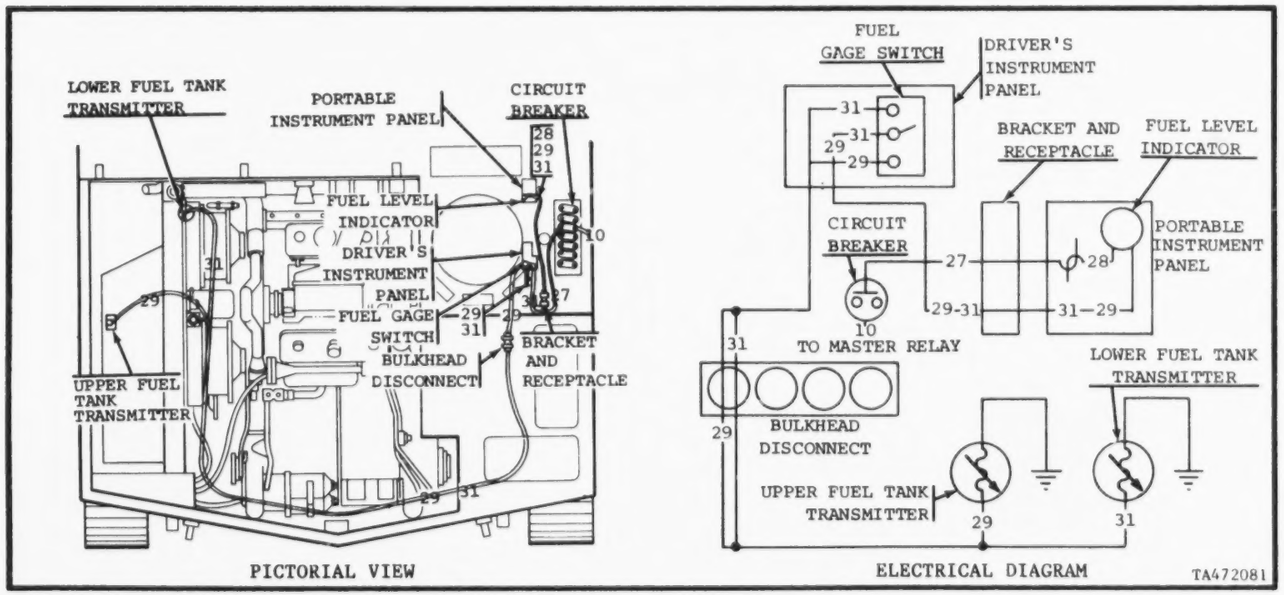
TA472080

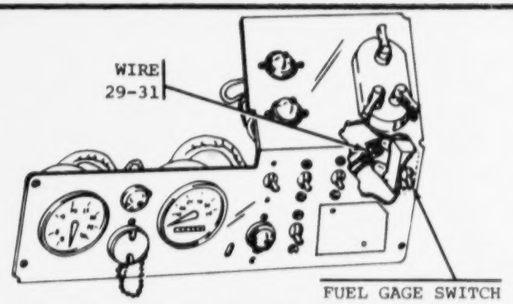
GAGES	FUEL LEVEL GAGE NEEDLE DOESN'T MOVE. Do steps A through C FUEL LEVEL GAGE SHOWS LEVEL FOR LOWER TANK BUT NOT FOR UPPER TANK. Do steps D and E. FUEL LEVEL GAGE SHOWS LEVEL FOR UPPER TANK BUT NOT FOR LOWER TANK. Do steps F and G.

1 Fill fuel tanks (ref. TM 9-2350-311-10).

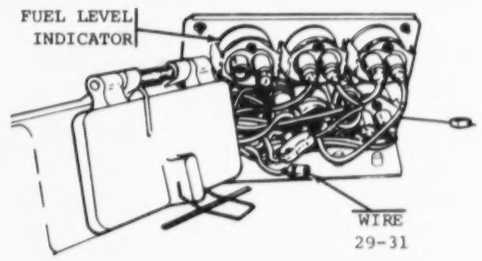
2 Troubleshoot FUEL LEVEL indicator circuit.

FUEL LEVEL INDICATOR CIRCUIT.

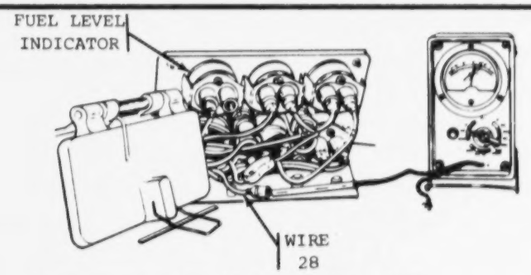




A Disconnect wire 29-31 from FUEL LEVEL GAGE switch. Turn MASTER switch ON. If FUEL LEVEL indicator shows maximum reading, ground wire 29-31, using jumper wire. If indicator fails to show minimum or maximum reading, go to step D. If indicator fails to show minimum or maximum reading, go to step B.



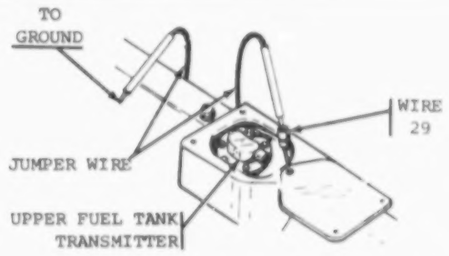
B Disconnect wire 29-31 from FUEL LEVEL indicator. Turn MASTER switch ON. If indicator shows a maximum reading, ground indicator. If indicator shows a minimum reading, repair or replace wire 29-31 (ref. p. 8-106). If indicator fails to show a minimum or maximum reading, go to step C.



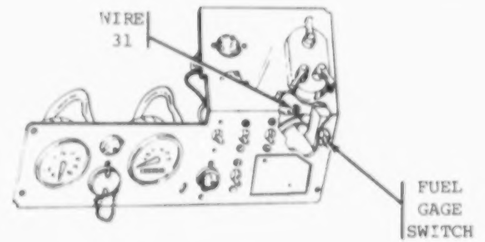
C Disconnect wire 28 from FUEL LEVEL indicator. Turn MASTER switch ON. Place red multimeter lead in wire 28, ground black lead, and check for voltage. If voltage is present, replace FUEL LEVEL indicator (ref. p. 8-22). If no voltage, repair or replace wires 27 and 28.

D Reconnect wire 29-31. Place FUEL GAGE switch in the UPPER position. Disconnect wire 29 from FUEL GAGE switch. Turn MASTER switch ON and place FUEL GAGE switch in UPPER position. If indicator shows a maximum reading, use a jumper and ground FUEL GAGE switch. If indicator shows a minimum reading, reconnect wire 29 and go to step E. If indicator fails to show a minimum or maximum reading, replace FUEL GAGE switch (ref. p. 8-22).

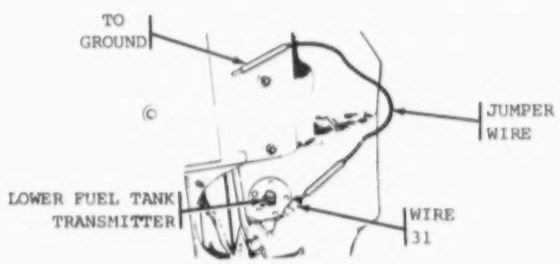
TA472082



E Remove access cover from shroud (ref. p. 6-8). Disconnect wire 29 at upper fuel tank transmitter. Turn MASTER switch on. If FUEL LEVEL indicator shows a maximum reading, use jumper wire to ground wire 29. If indicator shows a minimum reading, replace upper fuel tank transmitter (ref. p. 6-8). If indicator fails to show a minimum or maximum reading, repair or replace wire 29 (ref. p. 8-77).



F Place FUEL GAGE switch in LOWER position. Disconnect wire 31 from switch. Turn MASTER switch on. If FUEL LEVEL indicator shows a maximum reading, use a jumper and ground FUEL GAGE switch. If indicator shows a minimum reading, reconnect wire 31 and go to step G. If indicator fails to show a minimum or maximum reading, replace FUEL GAGE switch (ref. p. 8-84).



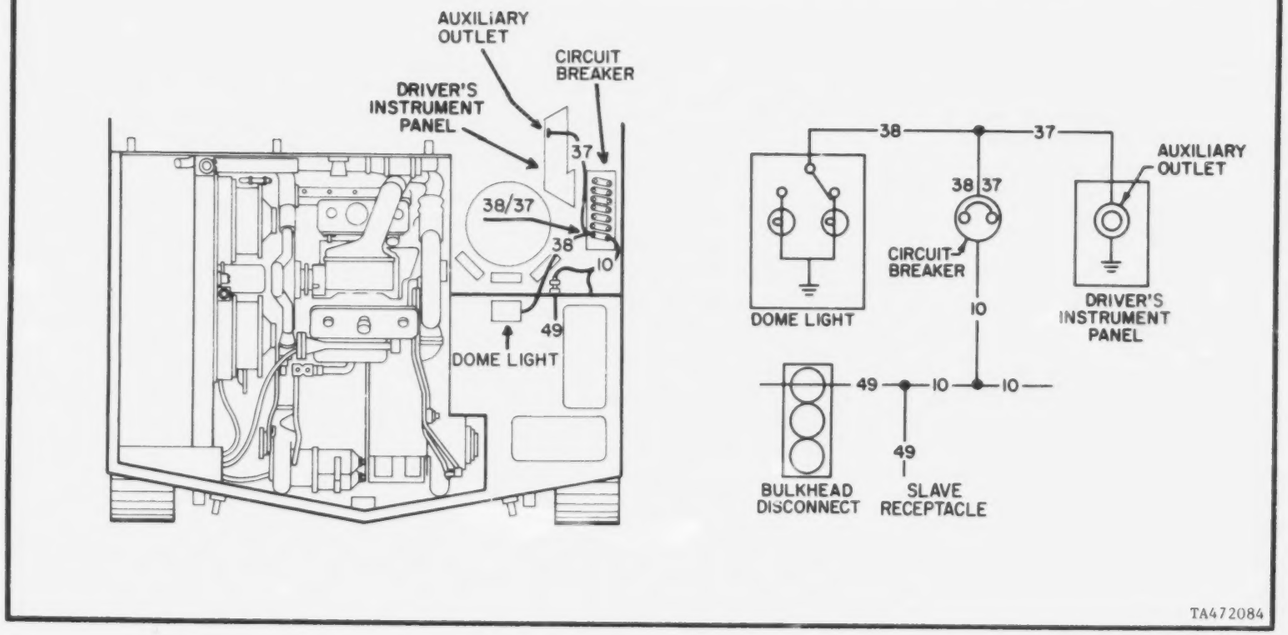
G Remove access cover from shroud (ref. p. 6-8). Disconnect wire 31 at lower fuel tank transmitter. Turn MASTER switch ON. If FUEL LEVEL indicator shows a maximum reading, use a jumper wire and ground wire 31. If indicator shows a minimum reading, replace lower fuel tank transmitter (ref. p. 6-8). If indicator fails to show a minimum or maximum reading, repair or replace wire 31 (ref. p. 8-77).

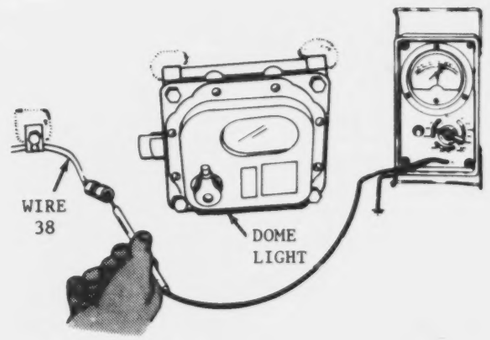
TA472083

DOMELIGHT	DOMELIGHT IS OUT.

Troubleshoot domelight circuit.

DOMELIGHT CIRCUIT

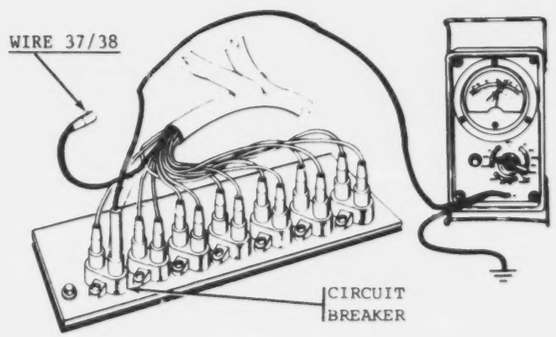




NOTE

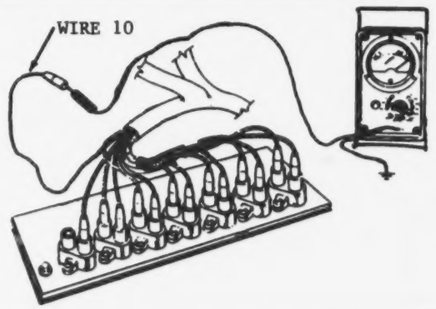
Move dome light switch to both positions. If one light comes on, go to step D.

A Disconnect wire 38 at dome light. Place red multimeter lead in connector and black lead to ground. Check for voltage. If voltage is present, go to step E. If voltage is not present, go to step B.

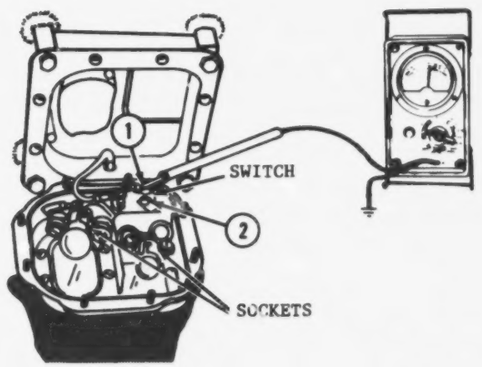


B Disconnect wire 37/38 at circuit breaker. Place red multimeter lead in circuit breaker output and black lead to ground. Check voltage. If voltage is present, repair or replace wire 37/38 (ref. p. 8-87). If voltage is not present, reconnect wire 37/38 and go to step C.

TA472085



C Disconnect wire 10 at circuit breaker. Place red multimeter lead in connector wire 10 and black lead to ground. Check voltage. If voltage is present, replace circuit breaker (ref. p. 8-62). If voltage is not present, repair or replace wire 10 (ref. p. 8-100 or 8-103).



NOTE

In the following step, if BO light is out, place red lead on switch terminal (1). If white light is out, place red lead on switch terminal (2).

D Remove cover from domelight (ref. p. 8-51). Turn switch on and check voltage through switch. Place red lead to output terminals (1 then 2) of switch and black lead to ground. Check voltage. If voltage is present, go to step E.

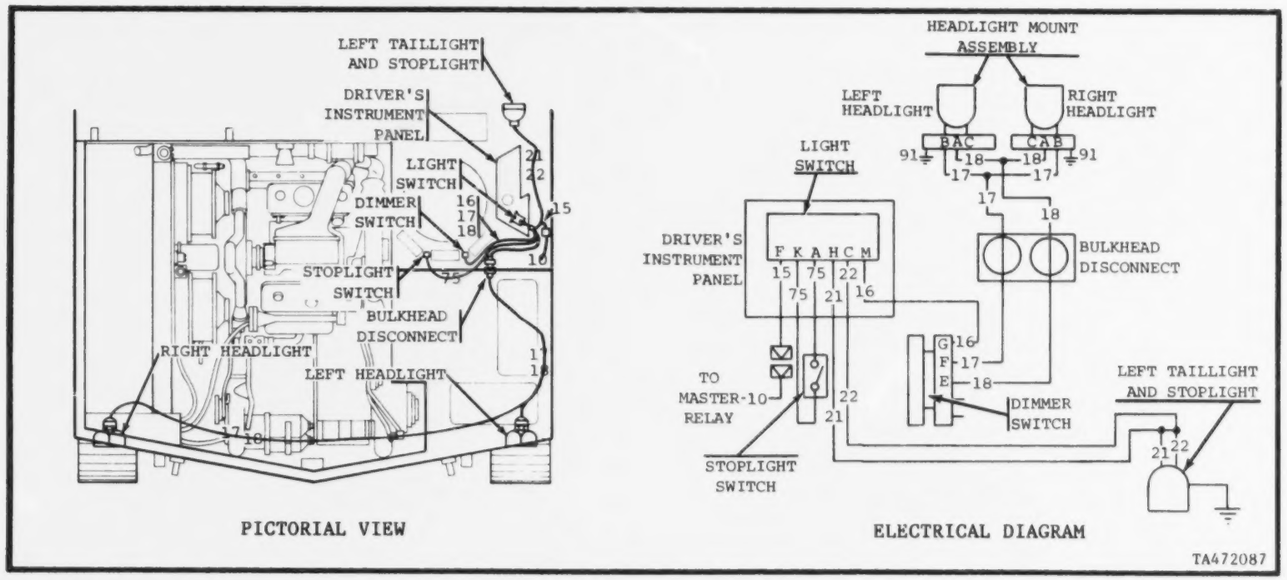
E Remove lamp socket assembly and check voltage to socket by placing red lead on contact in center of socket and black lead to ground. Check for voltage. If voltage is not present, replace socket assembly (ref. p. 8-51). If voltage is present, replace lamp.

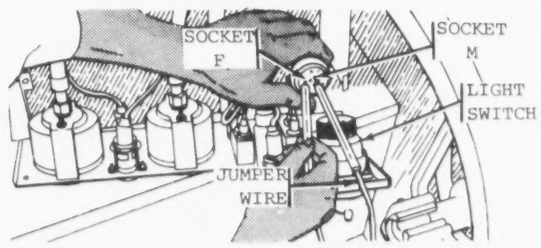
TA472086

SERVICE HEADLIGHTS, TAILLIGHTS, AND STOPLIGHTS	ALL LIGHTS ARE OUT. Do steps A and B.
	HEADLIGHTS ARE OUT. Do steps C through F.
	ONE BEAM ONLY ON HEADLIGHT OPERATES. Do step G.
	RIGHT OR LEFT HEADLIGHT IS OUT. Do steps H and I.
	TAILLIGHT IS OUT. Do steps J and K.
	STOPLIGHT IS OUT. Do steps L through P.

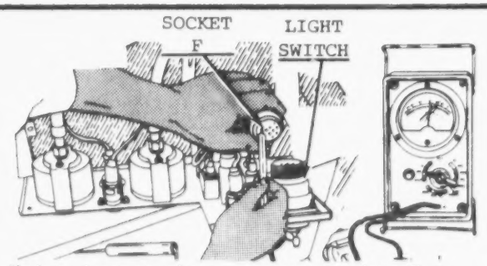
Troubleshoot service headlights, taillights, and stoplights circuit.

SERVICE HEADLIGHTS, TAILLIGHTS, AND STOPLIGHTS CIRCUITS.



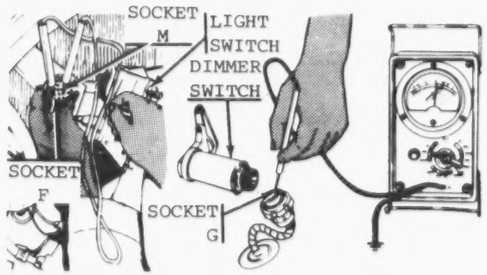


A Disconnect connector at light switch and turn MASTER switch ON. Using multimeter, place red lead in socket F and black lead to ground. If multimeter indicates zero volts, repair or replace wire 15 from connector to junction of wires 15 and 10 (ref. p. 8-87). If multimeter indicates voltage, go to step B.



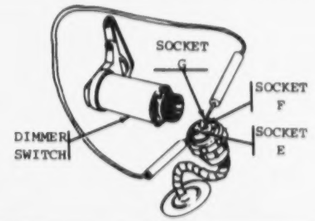
B Using jumper wire, connect socket F to socket M of light switch connector with MASTER switch ON. If lights come on, replace light switch (ref. p. 8-22). If headlights fail to come on, go to step D.

C Disconnect connector at light switch and turn MASTER switch ON. Using jumper wire, connect socket F to socket M. If headlights come on, replace light switch (ref. p. 8-22). If headlights fail to come on, go to step D.



D With jumper wire connecting sockets F and M of light switch and MASTER switch ON, place red multimeter lead in socket G of dimmer switch connector and ground black lead. If no voltage, repair or replace wire 16 from dimmer switch to light switch (ref. p. 8-87). If voltage is present, go to step E.

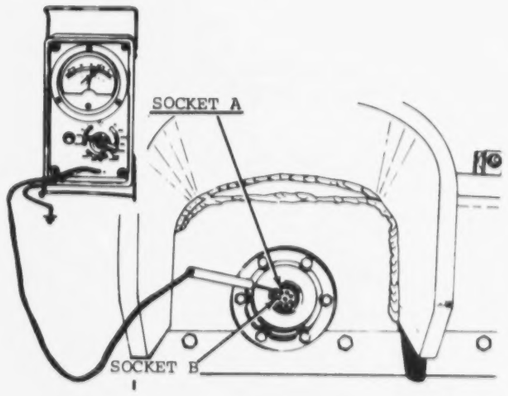
TA472088



E Remove jumper wire from sockets F and M and reconnect light switch connector. Using jumper wire, connect socket G to socket F of dimmer switch connector. Turn MASTER switch ON. Repeat test with jumper wire connecting sockets G and E of dimmer switch connector. If headlights come on, replace dimmer switch (ref. p. 8-66). If headlights fail to come on, go to step F.

NOTE

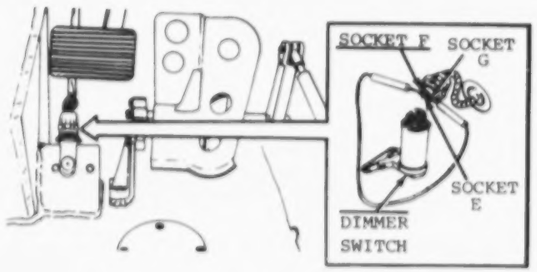
Light switch should be in SER DRIVE position.



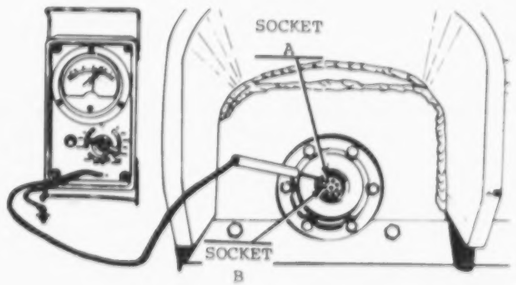
F Reconnect dimmer switch connector and remove headlight assembly. Using multimeter, check for voltage in sockets B and A. If no voltage, repair or replace wires 17 and 18 from headlight assembly to dimmer switch (ref. p. 8-77). If voltage is present, replace headlights (ref. p. 8-37).

G Both headlight assemblies have identical wiring. For troubleshooting the right or left headlight, follow same procedure. Remove inoperative headlight assembly (ref. p. 8-37) and turn headlight switch on. If low beam is inoperative, place dimmer switch in the low beam position. Then use multimeter to check for voltage in socket A. If no voltage in socket A, repair or replace wire 18 (ref. p. 8-77). If high beam is inoperative, place dimmer switch in the high beam position and check for voltage in socket B. If no voltage in socket B, repair or replace wire 17 (ref. p. 8-77). If voltage is present, replace sealed beam unit (ref. p. 8-40).

TA472089

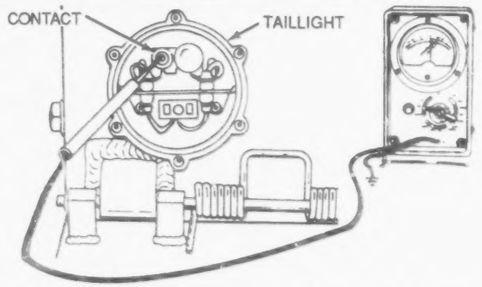


H Disconnect dimmer switch connector. Turn MASTER switch ON and place light switch in SER DRIVE position. If low beam is defective, use jumper wire to connect socket G to socket E. If high beam is defective, connect socket G to socket F. If headlights come on, replace dimmer switch (ref. p. 8-66). If headlights fail to come on, reconnect dimmer switch connector and go to step I.

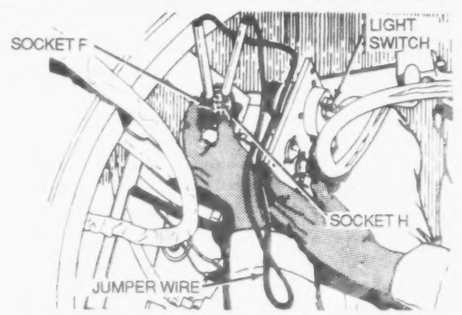


I Remove headlight assembly (ref. p. 8-37). If low beam is defective, place red multimeter lead in socket A and black lead to ground. If high beam is inoperative, place red lead in socket B and black lead to ground. Check for voltage. If no voltage, repair or replace wire 18 for defective low beam circuit and wire 17 for defective high beam circuit (ref. p. 8-77). If voltage is present, replace both sealed beam units (ref. p. 8-40).

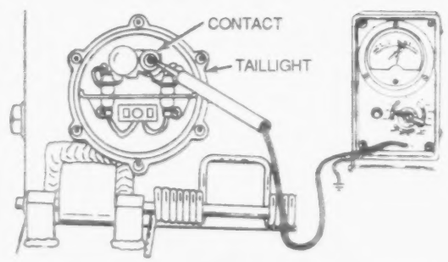
TA472090



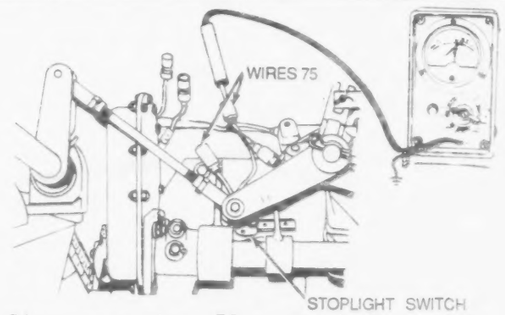
J Remove taillight cover (ref. p. 8-48) and turn MASTER switch ON. Turn light switch to SER DRIVE position. Remove taillight bulb (ref. p. 8-48). Using multimeter, place red lead in center contact and ground black lead. If voltage is present, replace bulb in socket and go to step K.



K Disconnect light switch connector. Turn MASTER switch ON. Using jumper wire, connect socket F to socket H. If taillight operates, replace light switch (8-22). If taillight fails to operate, repair or replace wire 21.

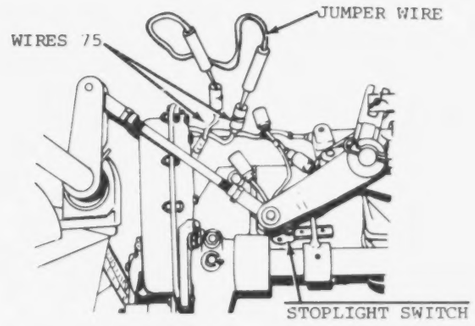


L Remove taillight cover, remove stoplight bulb and turn MASTER switch ON. Turn light switch to SER DRIVE position. Apply parking brake. Using multimeter, place red lead in center contact and ground black lead. If voltage is present, replace bulb. If no voltage, install stoplight bulb and go to step M.

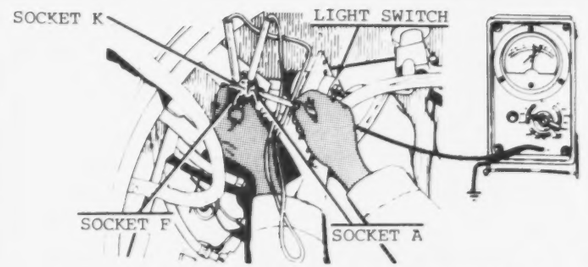


M Disconnect wires 75 at stoplight switch. Turn MASTER switch ON. Place red multimeter lead in one of the No. 75 wires and ground black lead. Check for voltage. Repeat for second wire. If voltage is present on one wire, go to step N. If no voltage, go to step O.

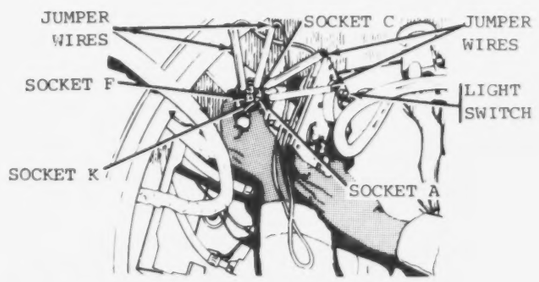
TA472091



N Using jumper wire, connect wire 75 to wire 75 at stoplight switch. If stoplight comes on, replace stoplight switch (ref. p. 8-66). If stoplight fails to come on, go to step O.



O Reconnect both no. 75 wires to stoplight switch and disconnect connector from light switch. Using jumper connect socket F of connector to socket K. Then place multimeter red lead in socket A of connector and ground black lead. If no voltage, repair or replace wire 75 from light switch to stoplight switch (ref. p. 8-87). If voltage is present, go to step P.



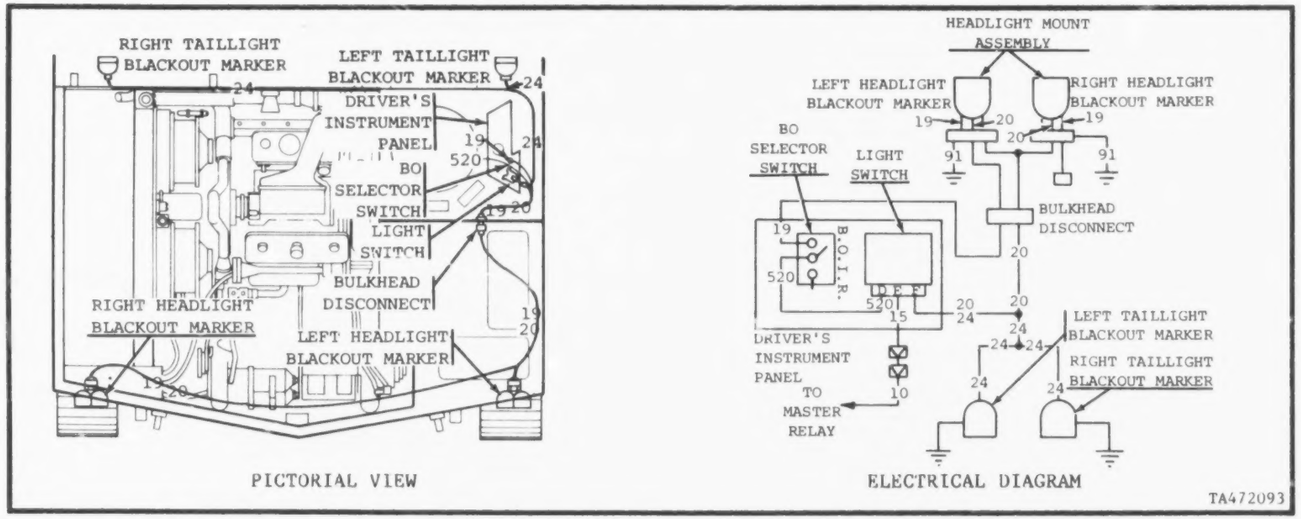
P With jumper wire connected to socket F and socket K of light switch connector, connect second jumper wire from socket A to socket C. If stoplight fails to come on, repair or replace wire 22 from light switch to stoplight (ref. p. 8-87). If stoplight comes on, replace light switch (ref. p. 8-22). Reconnect all wires.

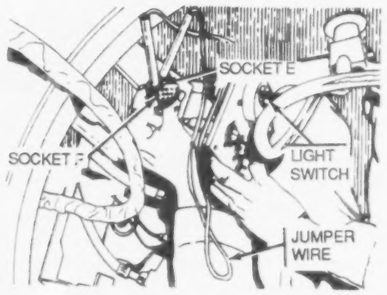
TA472092

BLACKOUT MARKERS AND BLACKOUT DRIVE LIGHTS	BLACKOUT MARKER LIGHTS ARE OUT. Do steps A and B. FRONT BLACKOUT MARKERS ARE OUT. Do step C. RICHT OR LEFT FRONT BLACKOUT MARKER IS OUT. Do step D. REAR BLACKOUT MARKERS ARE OUT. Do step E. RIGHT OR LEFT REAR BLACKOUT MARKER IS OUT. Do step F. BLACKOUT DRIVE LIGHT IS OUT. Do steps G through J.

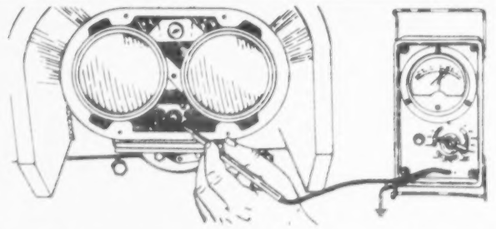
Troubleshoot blackout markers and blackout drive lights' circuits.

BLACKOUT MARKER AND BLACKOUT DRIVE LIGHTS' CIRCUITS.





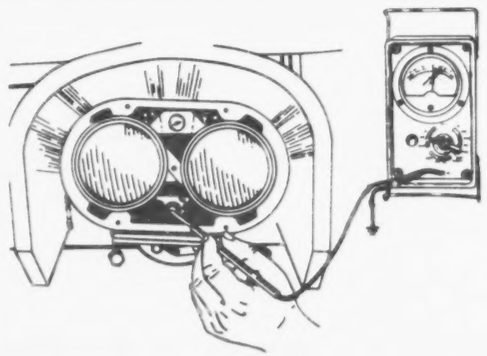
A Disconnect light switch connector. Use jumper wire to connect sockets F and E. Turn MASTER switch ON. If blackout (BO) marker lights come on, replace light switch (ref. p. 8-22). If BO marker lights fail to come on, go to step B.



B Remove cover from one BO marker and remove marker assembly (ref. p. 8-48). Use jumper to connect light switch sockets F and E. Turn MASTER switch ON. Place red multimeter lead on BO marker center contact and ground black lead. If voltage is present, replace marker assembly. If no voltage, repair or replace wire 20 and wire 19 (ref. p. 8-87).

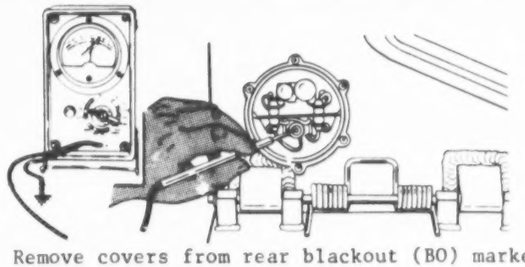
NOTE

If step B corrects condition on one light, repeat procedure for all marker lights.

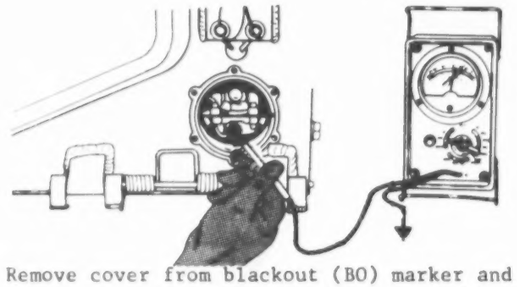


C Remove cover from front blackout (BO) marker lights and remove marker assemblies (ref. p. 8-40). Using multimeter place red lead in BO marker center contact and black lead to ground. Turn MASTER switch ON and move light switch to BO MARKER position. If voltage is present, replace marker assemblies. If no voltage, repair or replace wire 20 from both lights (ref. p. 8-87).

D Remove cover from inoperative blackout (BO) marker. Then remove BO marker assembly (ref. p. 8-40). Turn MASTER switch ON. Move light switch to BO MARKER position. Using multimeter, place red lead in center contact of socket and place black lead to ground. If voltage is present, replace marker assembly. If no voltage, repair or replace wire 20 (ref. p. 8-87).



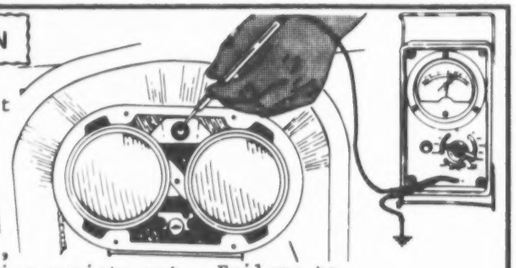
E Remove covers from rear blackout (BO) marker lights and remove BO marker assemblies (ref. p. 8-48). Turn MASTER switch ON and move light switch to BO MARKER position. Using multimeter, place red lead in center contact of socket and black lead to ground. If voltage is present, replace marker assembly. If no voltage, repair or replace wire 24 (ref. p. 8-87).



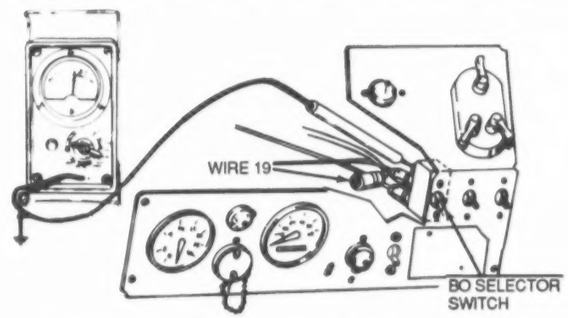
F Remove cover from blackout (BO) marker and remove BO marker assembly (ref. p. 8-48). Turn MASTER switch ON and move light switch to BO MARKER position. Using multimeter, place red lead in center contact and black lead to ground. If voltage is present, replace marker assembly. If no voltage, repair wire 24 (ref. p. 8-87).

CAUTION

BO drive light must be kept free of foreign material such as dirt, oil, grease, fingerprints ect. Failure to do so will cause damage to halogen bulb.

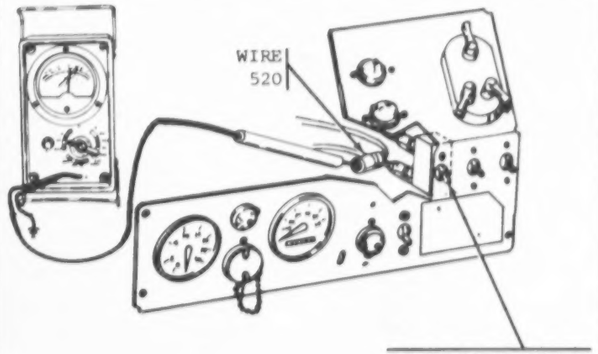


G Remove cover from blackout (BO) drive light. Remove reflector and BO drive light bulb (ref. p. 8-40). Turn MASTER switch ON and move light switch to BO DRIVE position. Using multimeter, place red lead in center contact and black lead to ground. If voltage is present, replace bulb. If no voltage, go to step H.

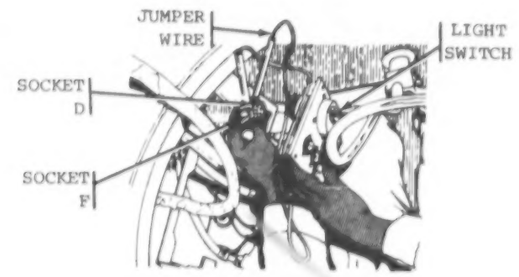


H Disconnect wire 19 from BO SELECTOR switch. Turn MASTER switch ON. Using multimeter, place red lead to switch and black lead to ground. If voltage is present, repair or replace wire 19 (ref. p. 8-87). If no voltage, go to step I.

TA472095



I Disconnect wire 520 from BO SELECTOR switch. Turn MASTER switch ON. Using multimeter, place red lead in wire 520 and black lead to ground. If voltage is present, replace BO SELECTOR switch (ref. p. 8-22). If no voltage, go to step J.



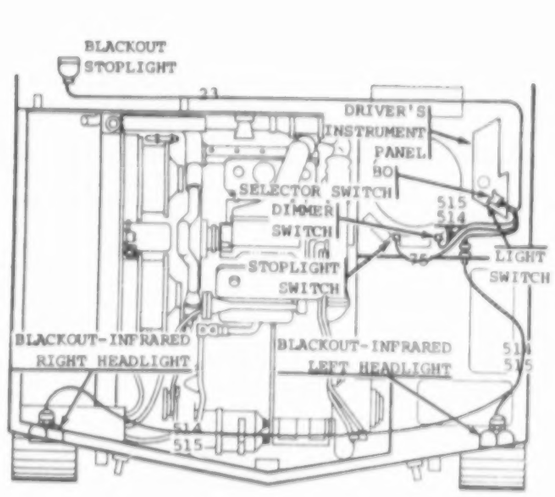
J Reconnect all wires and disconnect connector at light switch. Turn MASTER switch ON. Make sure BO SELECTOR switch is in the BOD position. Using jumper, connect sockets F and D. If BO drive light comes on, replace light switch (ref. p. 8-22). If BO light does not come on, repair or replace wire 520 (ref. p. 8-87).

TA472096

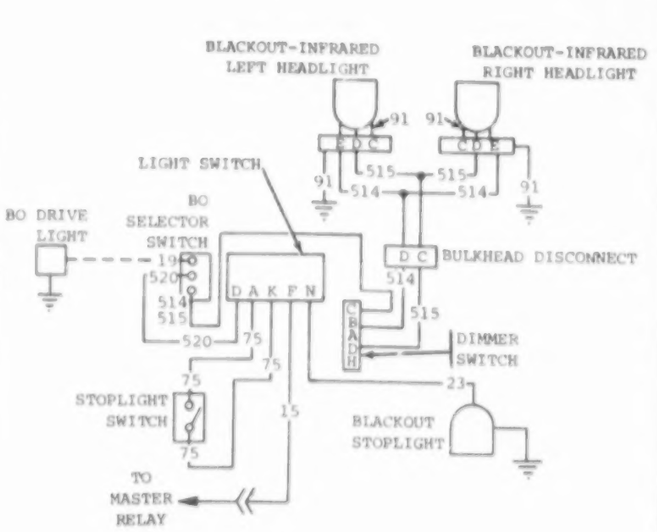
SERVICE BLACKOUT INFRARED HEADLIGHTS	BOTH BEAMS DON'T OPERATE. Do steps A through F. ONE BEAM DOESN'T OPERATE. Do steps G and H. BLACKOUT STOPLIGHT IS OUT. Do steps I and J.

Troubleshoot service blackout-infrared headlights and blackout stoplights' circuits.

SERVICE BLACKOUT-INFRARED HEADLIGHTS AND BLACKOUT STOPLIGHTS' CIRCUITS.

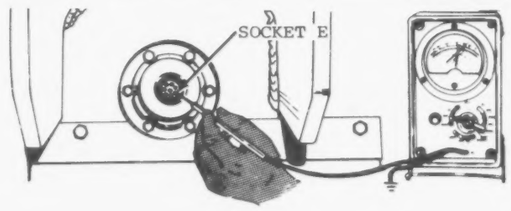


PICTORIAL VIEW



ELECTRICAL DIAGRAM

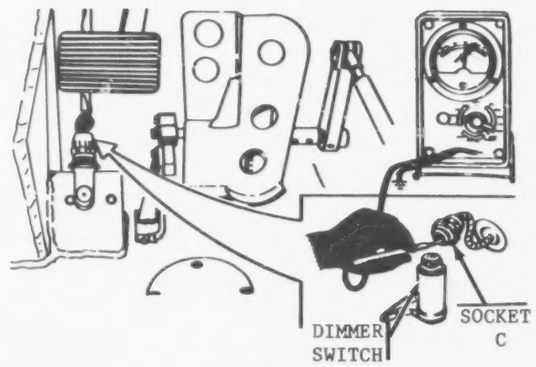
TA472097



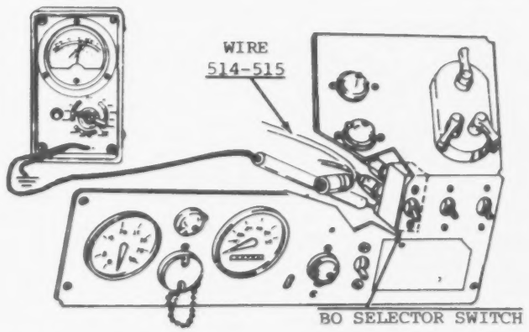
NOTE

Before performing these steps, ensure that service drive lights are operational.

A Remove blackout-infrared (BO-IR) headlight assembly. Turn MASTER switch ON. Move light switch to BO DRIVE position, and BO SELECTOR switch to IR position. Place red multimeter lead in socket E and ground black lead. If no voltage, push dimmer switch. If voltage is present, replace sealed beam unit (ref. p. 8-40). If no voltage, go to step B.

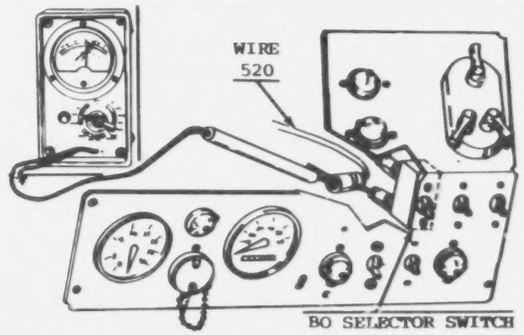


B Disconnect dimmer switch connector. Turn MASTER switch ON. Place red multimeter lead in socket X of connector and ground black lead. If no voltage, go to step C. If voltage is present, go to step F.

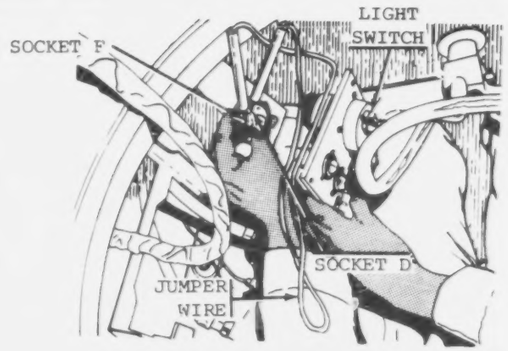


C Disconnect wire 514-515 at BO SELECTOR switch. With switch in IR position, place red multimeter lead on switch terminal and ground black lead. If voltage is present, repair or replace wire 514-515 (ref. p. 8-87). If no voltage go to step D.

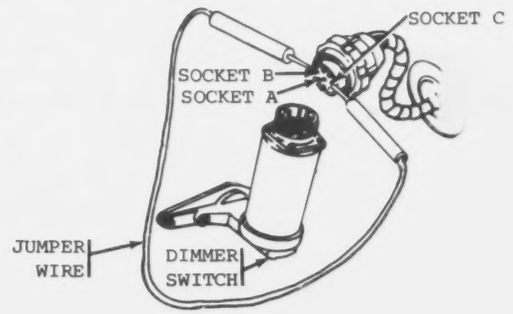
TA472098



D Disconnect wire 520 from BO SELECTOR switch. Turn MASTER switch ON. Place red multimeter lead in wire 520 and ground black lead. If voltage is present, replace BO SELECTOR switch (ref. p. 8-22). If no voltage go to step E.

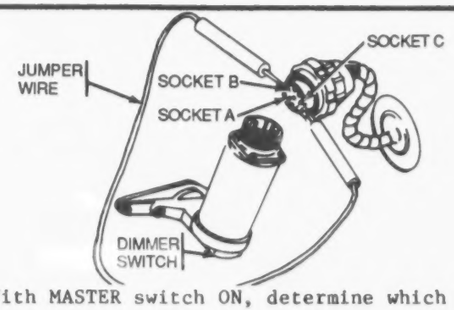


E Reconnect all wires. Disconnect light switch connnector. Turn MASTER switch ON. Using jumper wire, connect socket F to socket D. If IR lights fail to operate, repair or replace wire 520 (ref. p. 8-87).

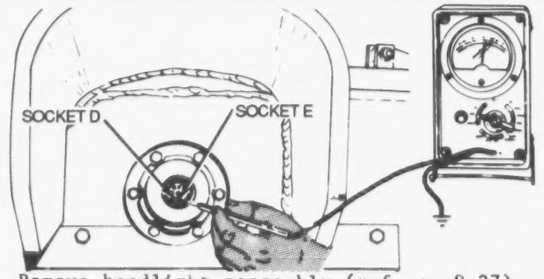


F Turn MASTER switch ON. Using jumper, connect socket C of dimmer switch conector to socket B and then to socket A. If IR lights fail to operate when socket C is connected to socket B, repair or replace wire 514 (ref. p. 8-87). If IR lights fail to operate when socket C is connected to socket A, repair or replace wire 515 (ref. p. 8-87). If both lights operate when jumper wire is used, replace dimmer switch (p. 8-66).

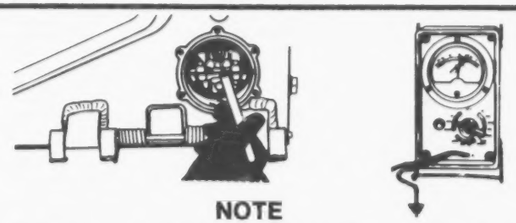
TA472099



G With MASTER switch ON, determine which beam is inoperative by using high beam indicator. Disconnect connector from dimmer switch and using jumper wire, connect socket C of connector to socket N if high beam is inoperative, and to socket A if low beam is inoperative. If lights operate, replace dimmer switch (ref p. 8-66). If lights fail to operate, go to step H.



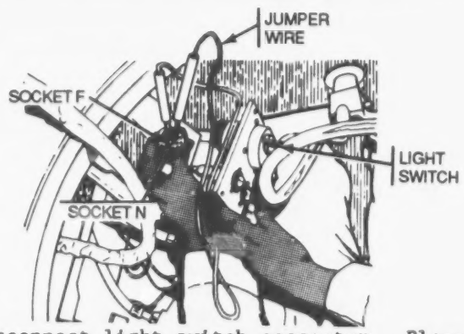
H Remove headlight asssembly (ref. p. 8-37). If high beam is inoperative place red multimeter lead in socket E. If low beam is inoperative, place red lead in socket D. Ground black lead. If voltage is present, replace sealed beam units (ref. p. 8-40). If no voltage, repair or replace wire 515 if low beam is defective or wire 514 if high beam is defective (ref. p. 8-66).



NOTE

Before performing these steps, ensure that service stoplight is operational.

I Remove blackout (BO) stoplight LED assembly (ref. p. 8-48). Turn MASTER switch ON. Then move light switch to BO DRIVE position and apply parking brake. Using multimeter, place red lead in center contact and ground black lead. If voltage is present, replace LED assembly. If no voltage, go to step J.



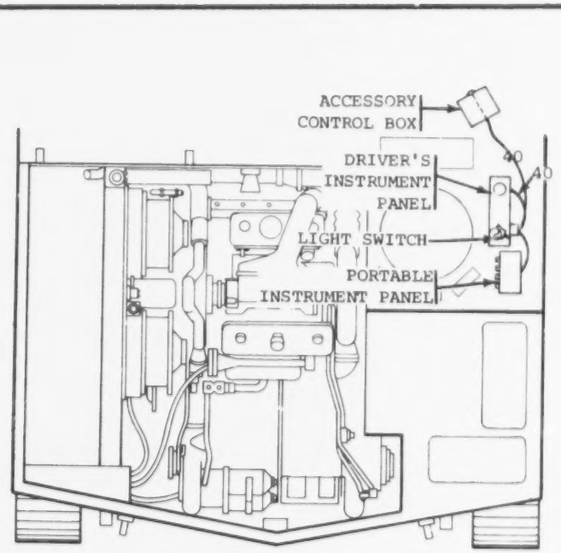
J Disconnect light switch connector. Place jumper wire from socket F to socket N. If BO stoplight operates, replace light switch. Apply brakes. If light fails to operate, repair or replace wire 23 (ref. p. 8-87).

TA472100

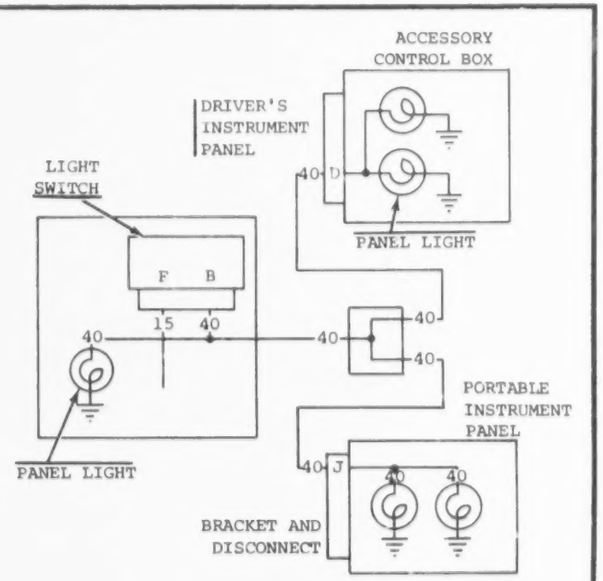
INSTRUMENT PANEL LIGHTS	ONE OR MORE LIGHTS ARE OUT. Do step A. ALL LIGHTS ARE OUT. Do step B.

Troubleshoot instrument panel light circuit.

INSTRUMENT PANEL LIGHT CIRCUIT

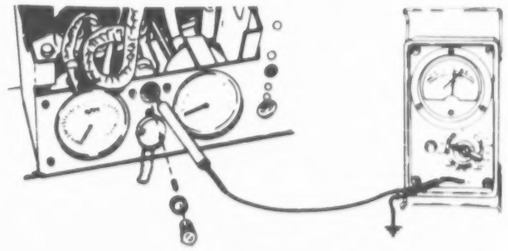


PICTORIAL VIEW



ELECTRICAL DIAGRAM

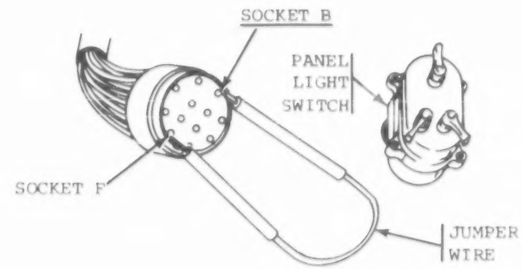
TA472101



NOTE

Before troubleshooting panel lights, be sure that service drive lights are operational.

A Remove inoperative panel light bulb. Turn MASTER switch and panel light switch ON. Using multimeter, place red lead in center contact. Ground black lead. If voltage is present, replace bulb. If no voltage, repair wire 40.



B Disconnect light switch connector and use jumper to connect socket F to socket B. Turn MASTER switch and panel lights ON. If panel lights operate, replace light switch. If panel lights fail to operate, repair or replace wire 40 (ref. p. 8-87).

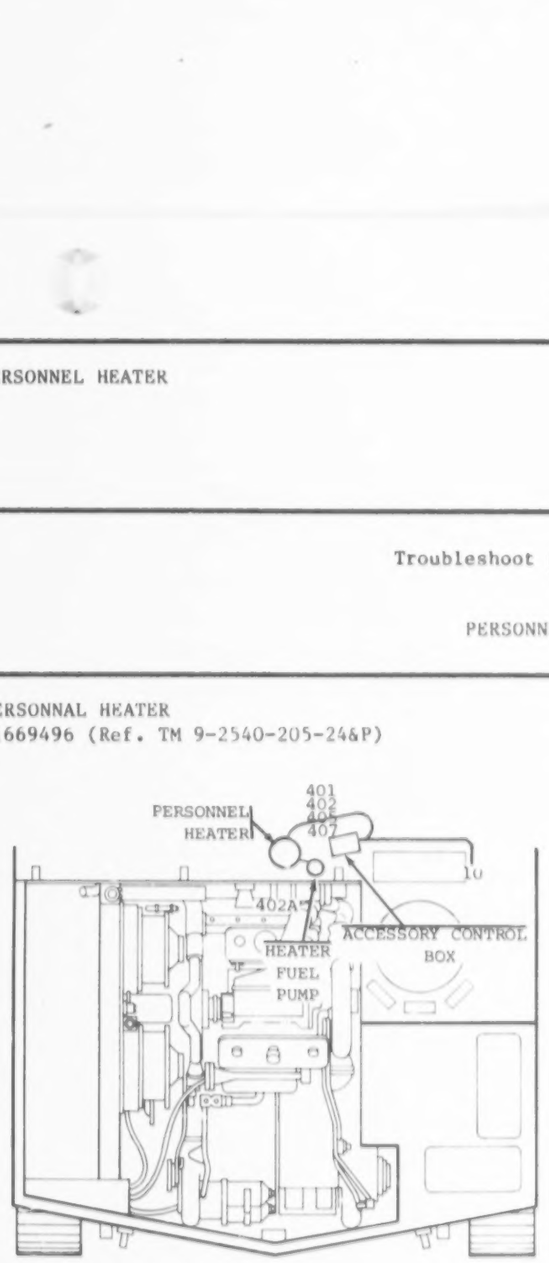
TA472102

PERSONNEL HEATER	PERSONNEL HEATER DOESN'T OPERATE. Do steps A through L. HEATER WILL NOT STOP WHEN SWITCH IS OFF. Notify direct support maintenance.

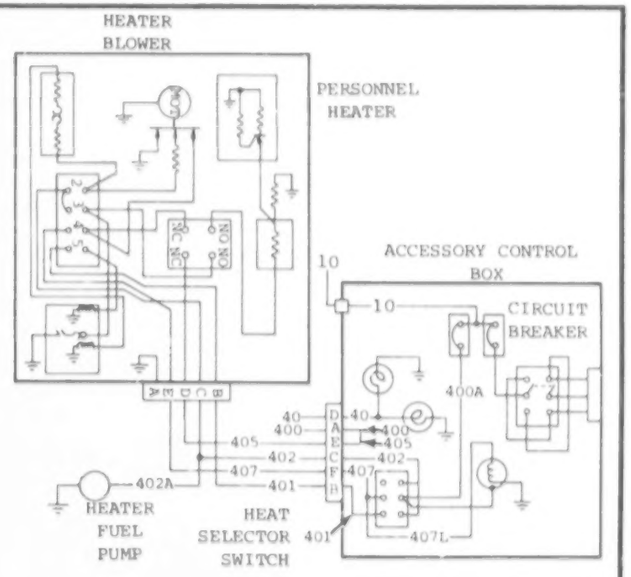
Troubleshoot personnel heat circuit.

PERSONNEL HEATER CIRCUIT

PERSONNAL HEATER
11669496 (Ref. TM 9-2540-205-24&P)

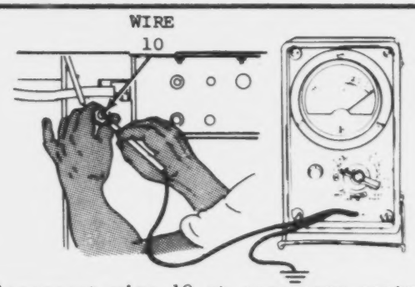


PICTORIAL VIEW

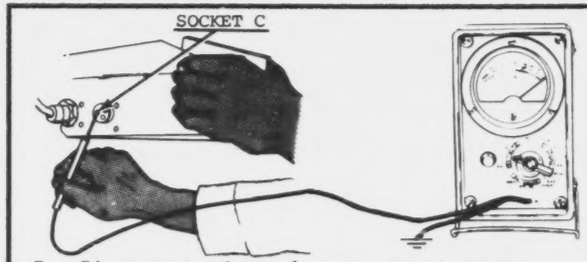


ELECTRICAL DIAGRAM

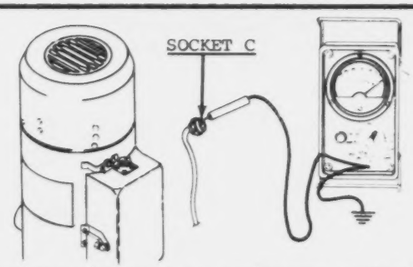
TA472103



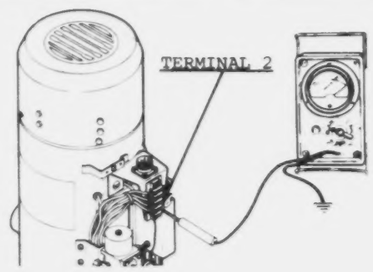
A Disconnect wire 10 at accessory control box. Turn MASTER switch ON. Place red lead of multimeter on wire 10 socket in connector. If voltage is not present, repair or replace wire 10. If voltage is present, reconnect wire 10 to accessory control box and go to step B.



B Disconnect wiring harness at accessory control box. MASTER switch ON, heat selector switch low. Place red lead of multimeter in socket C (wire 402) of accessory control box and black lead to ground. If voltage is not present, go to step H. If voltage is present, go to step C.



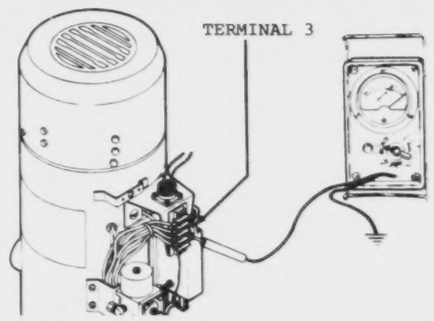
C Reconnect harness at accessory control box. Disconnect wiring harness at personnel heater. Turn MASTER switch ON. Heat selector switch low. Place red lead of multimeter in socket C (wire 402) and black lead to ground. Check for voltage. Repeat voltage check on socket D (wire 405). If voltage is not present in both wires, repair or replace defective wires. If voltage is present, reconnect harness and go to step D.



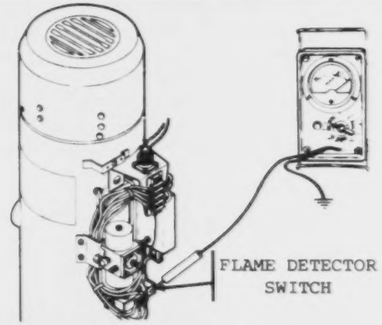
D Remove personnel heater cover (ref. TM 9-2540-205-24&P). Turn MASTER switch ON, heat selector switch low. Place red lead of multimeter on Terminal 2 (output) and black lead to ground. Check for voltage. If voltage is not present, notify Support Maintenance. If voltage is present, go to step E.

TA472104

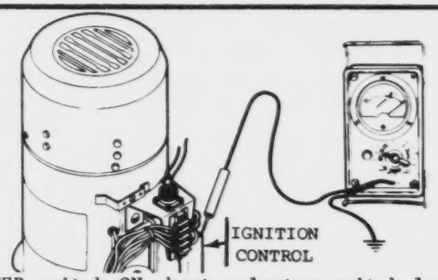
best copy available



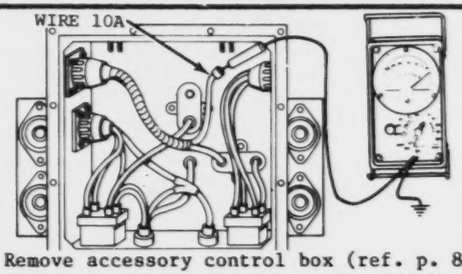
E MASTER switch ON, heat selector switch low. Place red lead of multimeter on terminal 3 (output) and black lead to ground. If voltage is not present, remove heater to Support Maintenance (ref. TM 9-2540-205-24&P). If voltage is present, go to step F.



F MASTER switch ON, heat selector switch low. Place red lead on output terminal of flame detector switch to ignition control and black lead to ground. If voltage is not present, replace flame detector switch (ref. TM 9-2540-205-24&P). If voltage is present, go to step G.

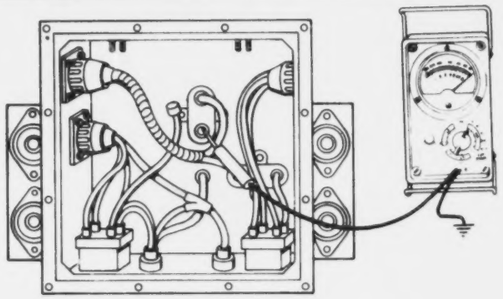


G MASTER switch ON, heat selector switch low. Place red lead of multimeter on ignition control (output) lead and black lead to ground. If voltage is not present, replace ignition control (ref. TM 9-2540-205-24&P). If voltage is present, replace igniter (ref. TM 9-2540-205-24&P).

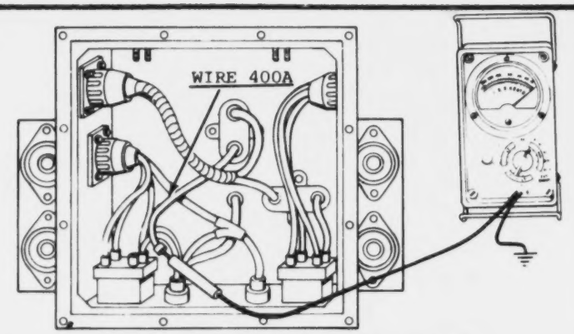


H Remove accessory control box (ref. p. 8-32). Remove cover and disconect wire 10A from circuit breaker. MASTER switch ON. Place red lead of multimeter in wire 10A connector and black lead to ground. If voltage is not present, replace wire 10 in accessory control box. If voltage is present, go to step I.

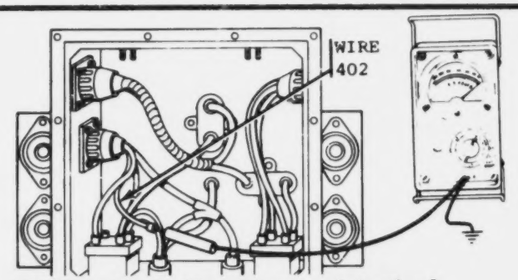
TA472105



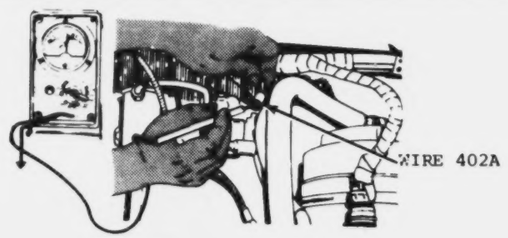
I Disconnect wire 400A from circuit breaker. MASTER switch ON. Place red lead of multimeter in circuit breaker terminal and black lead to ground. If voltage is not present, replace circuit breaker (ref. p. 8-32). If voltage is present, go to step J.



J MASTER switch ON. Place red lead of multimeter on heat selector switch (input wire 400A) and black lead to ground. If voltage is not present, repair or replace wire 400A. If voltage is present, go to step K.



K MASTER switch ON. Place red lead of multimeter on heat selector switch output (wire 402) and black lead to ground. Move heat selector switch to HIGH and LOW positions (position red lead on HIGH and LOW terminals). If voltage is not present in both positions, replace switch (ref. p. 8-32). If voltage is present, go to step L.



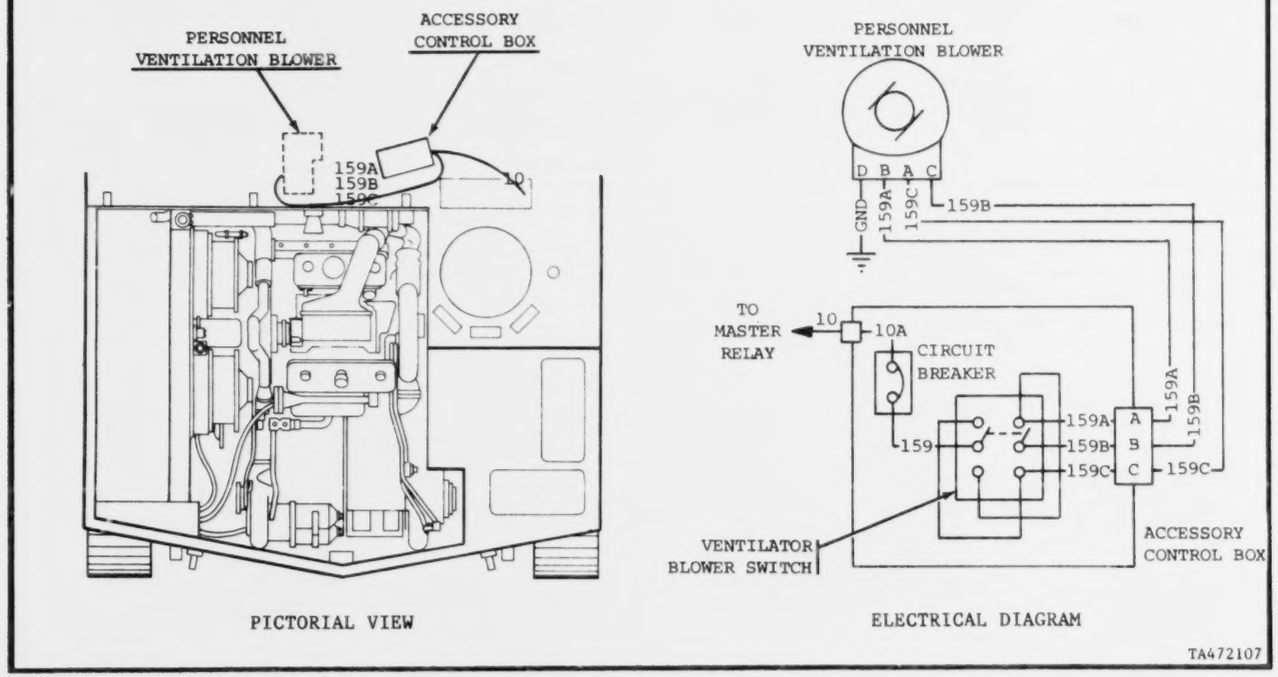
L Assemble and install accessory control box (ref. p. 8-32). Disconnect wire 402A at fuel pump. MASTER switch ON, heat selector switch low. Place red lead of multimeter in wire 402A. If voltage is present, replace fuel pump. If heater still does not operate, replace heater (ref. p. 11-50).

TA472106

PERSONNEL VENTILATION BLOWER	PERSONNEL VENTILATION BLOWER DOESN'T OPERATE.

Troubleshoot personnel ventilation blower circuit.

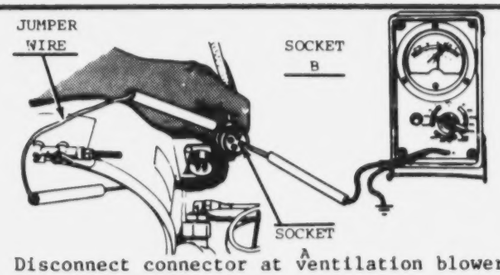
PERSONNEL VENTILATION BLOWER CIRCUIT.



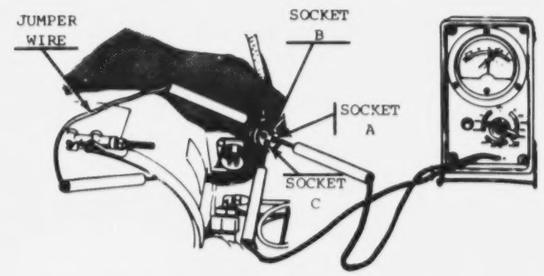
PICTORIAL VIEW

ELECTRICAL DIAGRAM

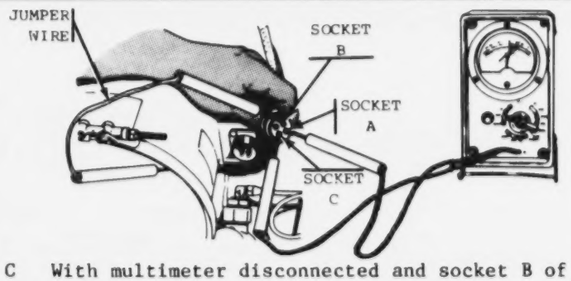
TA472107



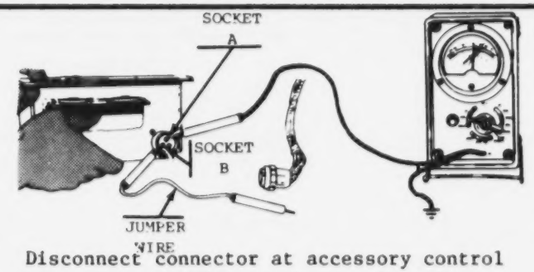
A Disconnect connector at ventilation blower. Turn MASTER switch ON. Install jumper between socket B of cable and ground, Connect red multimeter lead to socket A of cable and black lead to ground. Place VENTILATOR BLOWER switch in the EXHAUST and then in the INTAKE positions. If voltage is present in one position, go to step B. If no voltage, go to step D.



B With MASTER switch ON and connections and VENTILATION BLOWER switch in position where voltage was obtained in step A, move black multimeter lead to socket C of cable. If voltage is present, go to step C. If no voltage, go to step D.

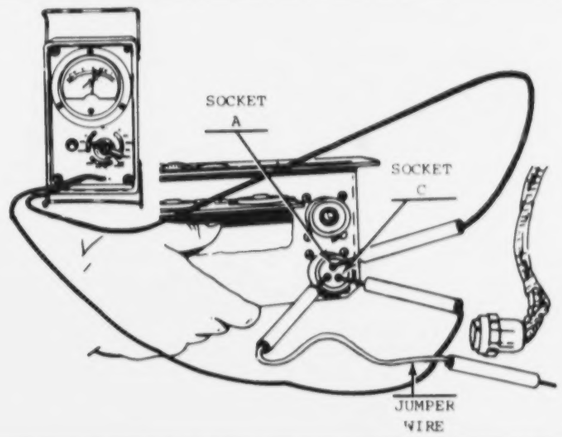


C With multimeter disconnected and socket B of cable grounded, place VENTILATOR BLOWER switch in opposite position of that where voltage was obtained in steps A and B. With MASTER switch ON, connect red multimeter lead to socket C and black lead to socket A. If voltage is present here and in steps A and B, replace ventilation blower (ref. p. 11-59). If no voltage, go to step D.

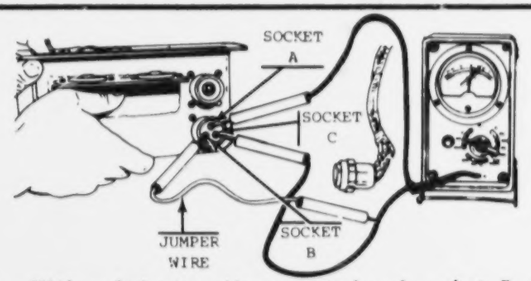


D Disconnect connector at accessory control box. Turn MASTER switch ON. Install a jumper wire between socket B of accessory control box and ground. Connect red multimeter lead to socket A of accessory control box and black lead to ground. Place VENTILATOR BLOWER switch in the EXHAUST and then in the INTAKE positions. If voltage is present, go to step E. If no voltage in either position, go to step G.

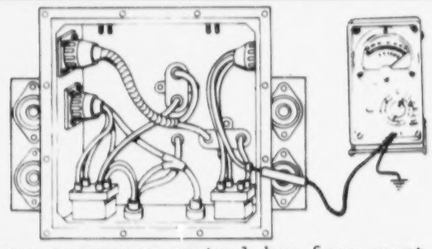
TA472108



E Turn MASTER switch ON. With connections and VENTILATOR BLOWER switch in position where voltage was obtained in step D, move black multimeter lead to socket C. If voltage is present, go to step F. If no voltage, go to step G.

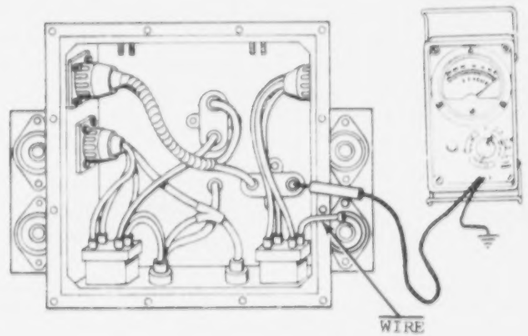


F With multimeter disconnected and socket B of the accessory control box grounded, place VENTILATOR BLOWER switch in opposite position of that where voltage was obtained in steps D and E. Connect red multimeter lead to socket C and black lead to socket A. If voltage is present, check cable between accessory control box and ventilation blower and damage. If no voltage, go to step G.

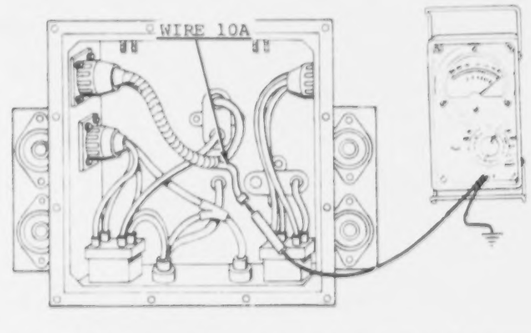


G Remove accessory control box from mount and then remove cover. Visually inspect wires from VENTILATOR BLOWER switch to connector in box and repair if necessary. If wires are good, turn MASTER switch ON and place red multimeter lead on VENTILATOR BLOWER switch input (wire 159) and ground black lead. If voltage is present, replace VENTILATOR BLOWER switch (ref. p. 8-32). If no voltage, go to step H.

TA472109



H Turn MASTER switch ON. Place red multimeter lead in circuit breaker output (wire 159) and ground black lead. If voltage is present, repair or replace wire 159 (ref. p. 8-118). If no voltage, go to step I.



I Turn MASTER switch ON. Place red multimeter lead on circuit breaker input (wire 10) and ground black lead. If voltage is present, replace circuit breaker (ref. p. 8-32). If no voltage, repair or replace wire 10 (ref. p. 8-120).

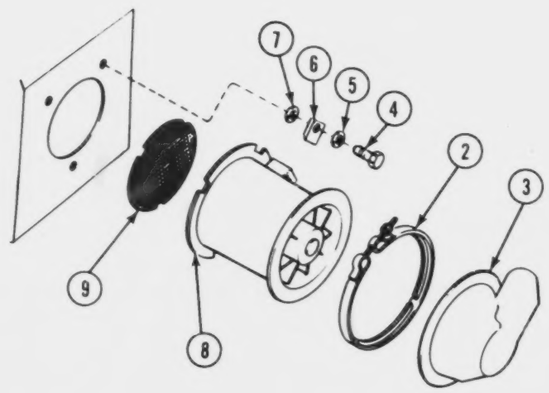
TA472110

PERSONNEL VENTILATION BLOWER	AIR CIRCULATION ISN'T SUFFICIENT.

1 Clean air intake screen.

2 Replace blower.

PERSONNEL AIR VENTILATING SYSTEM: REMOVAL AND INSTALLATION



REMOVAL

A Turn MASTER switch off.

B Disconnect electrical plug at receptacle (1).

C Remove clamp (2) and elbow (3).

D Remove three screws (4), six flatwashers (5), plates (6) and flatwashers (7).

E Remove fan assembly (8) and screen (9).

NCTE

Clean screen with drycleaning solvent, or water and nonsudsing detergent.

INSTALLATION

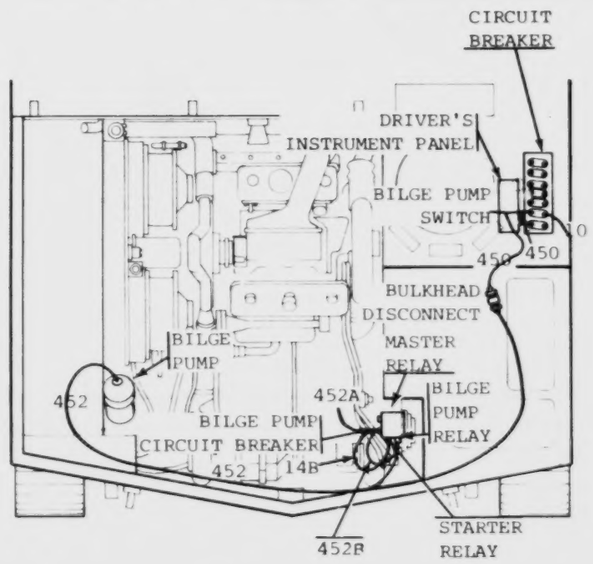
Reverse removal procedures.

TA472111

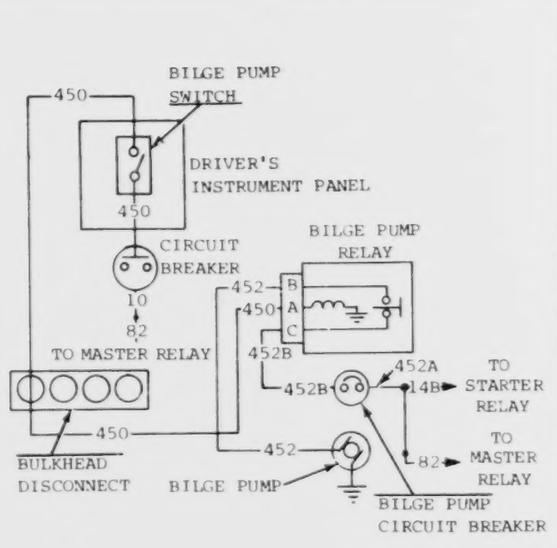
BILGE PUMP	BILGE PUMP DOESN'T OPERATE.

Troubleshoot bilge pump circuit.

BILGE PUMP CIRCUIT

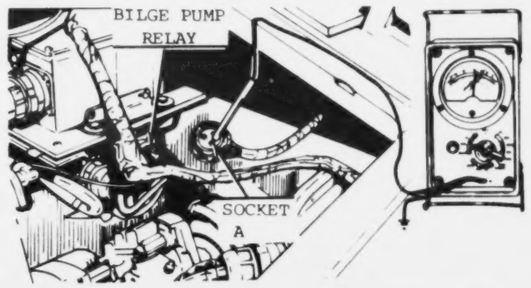


PICTORIAL VIEW

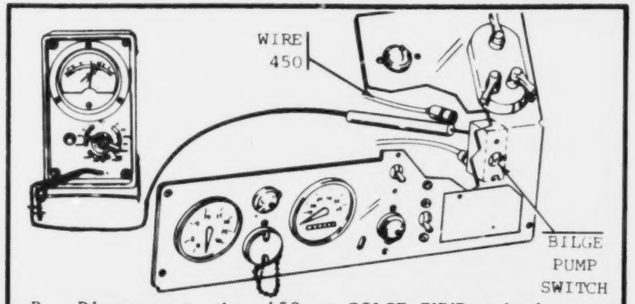


ELECTRICAL DIAGRAM

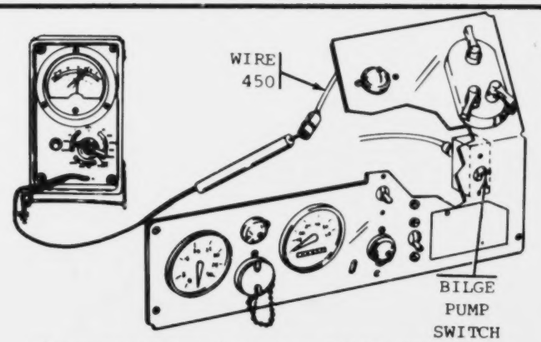
TA472112



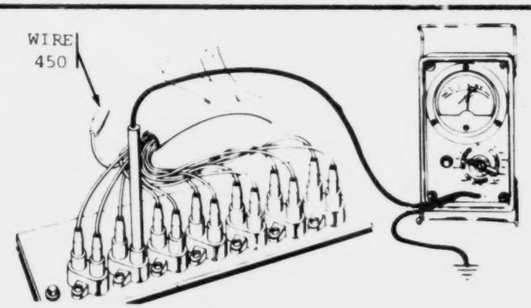
A Disconnect connector at bilge pump relay. Turn MASTER switch and BILGE PUMP switch ON. Place red multimeter lead in socket A and black lead to ground. Check for voltage. If no voltage, go to step B. If voltage is present, go to step F.



B Disconnect wire 450 at BILGE PUMP switch output. Turn MASTER switch and BILGE PUMP switch ON. Place red multimeter lead in switch output, ground black lead, and check for voltage at switch output. If voltage is present, repair or replace wire 450 (ref. p. 8-87). If no voltage, go to step C.

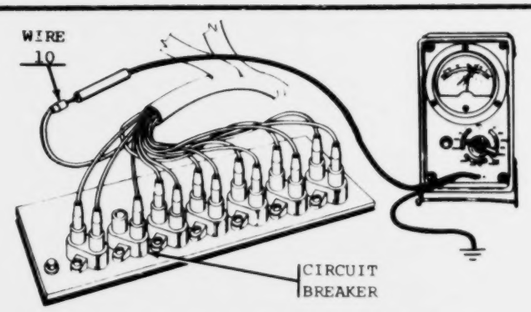


C Disconnect wire 450 from BILGE PUMP switch input. Turn MASTER switch ON. Using multimeter, place red lead on wire 450 and black lead to ground. If voltage is present, replace BILGE PUMP switch (ref. p. 8-22). If no voltage, go to step D.

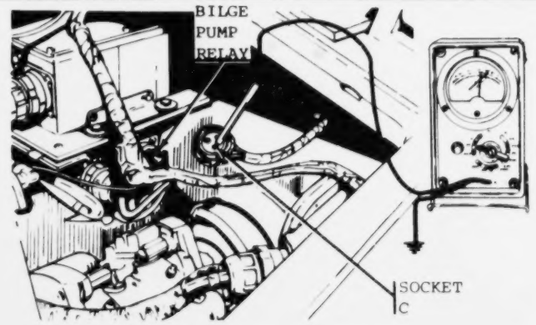


D Disconnect wire 450 at circuit breaker output. Turn MASTER switch ON. Using multimeter, place red lead in circuit breaker output. Ground black lead. If voltage is present, repair or replace wire 450 (ref. p. 8-87). If no voltage, go to step E.

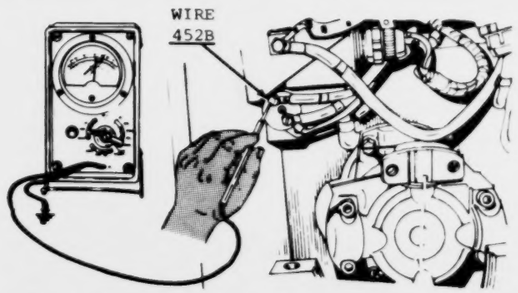
TA472113



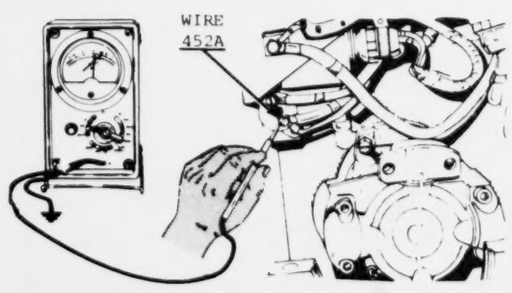
E Disconnect wire 10 from circuit breaker input. Turn MASTER switch ON. Using multimeter, place red lead in wire 10. Ground black lead. If voltage is present, replace circuit breaker (ref. p. 8-62). If no voltage, repair or replace wire 10 (ref. p. 8-100 or 8-103).



F With bilge pump relay connector disconnected, turn MASTER switch ON. Place red multimeter lead in socket C (wire 452B), and black lead to ground. If no voltage, go to step G. If voltage is present, go to step I.

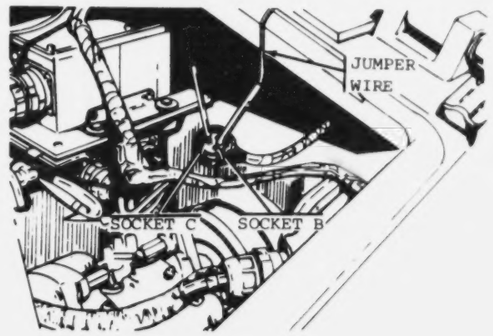


G Turn MASTER switch ON. Place red multimeter lead on bilge pump circuit breaker output (wire 452B) and ground black lead. If voltage is present, repair or replace wire 452B (ref. p. 8-77). If no voltage, go to step H.

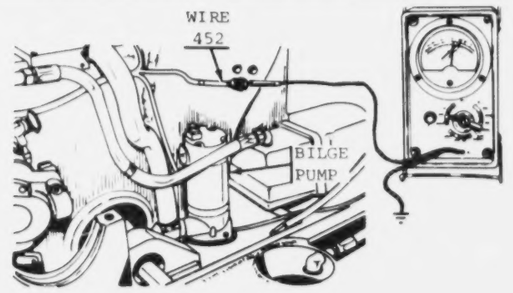


H Turn MASTER switch ON. Place red multimeter lead on bilge pump circuit breaker input (wire 452A) and ground black lead. If voltage is present, replace circuit breaker (ref. p. 8-61). If no voltage, repair or replace wire 452A (ref. p. 8-139).

TA472114



I Turn MASTER switch ON. Use jumper wire to connect socket C (wire 152B) to socket B (wire 452). If bilge pump operates, replace bilge pump relay (ref. p. 8-59). If bilge pump fails to operate, go to step J.

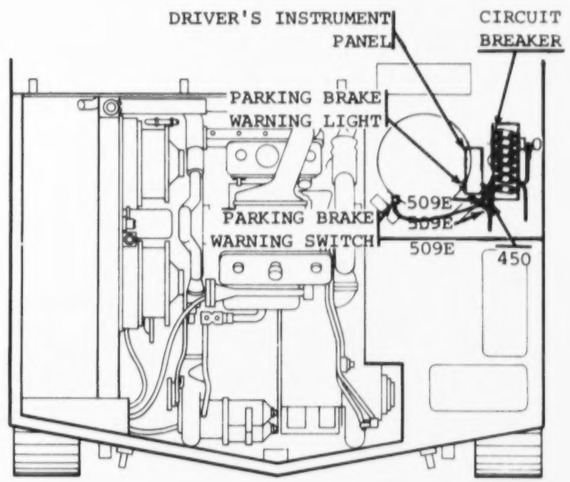


J Turn MASTER switch ON. With jumper connected to socket C and socket B, disconnect wire 452 at bulge pump. Place red multimeter lead in wire 452 and ground black lead. If voltage is present, replace bilge pump (ref. p. 11-48). If no voltage, repair or replace wire 452 (ref. p. 8-77).

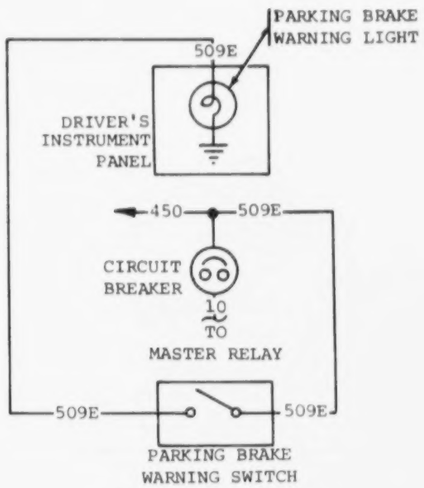
PARKING BRAKE	PARKING BRAKE WARNING LIGHT IS OUT.

Troubleshoot parking brake warning light circuit.

PARKING BRAKE WARNING LIGHT CIRCUIT.

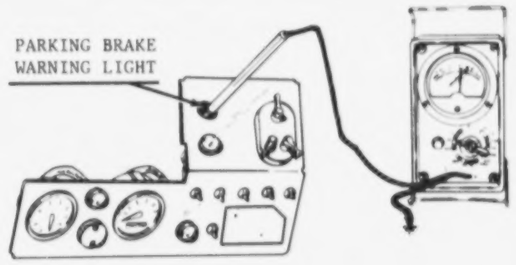


PICTORIAL VIEW

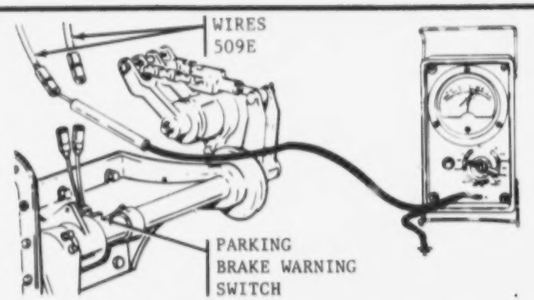


ELECTRICAL DIAGRAM

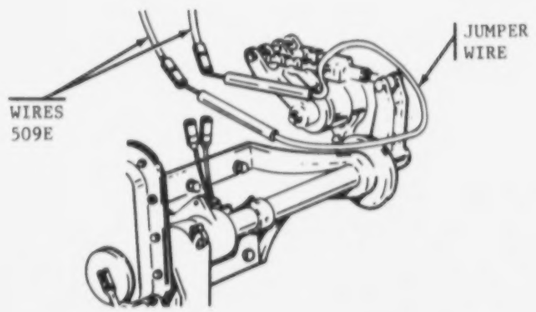
TA472116



A Remove bulb from parking brake warning light. With MASTER switch on and brakes applied, check voltage by placing red multimeter lead in center contact and ground black lead. If voltage is present, replace bulb. If no voltage, go to step B.



B Disconnect both 509E wires from parking brake warning switch. Place red multimeter lead in either wire 509E, ground black lead, and check for voltage. Repeat for second wire 509E. If no voltage on either wire, repair or replace wire 509E (ref. p. 8-84). If voltage is present, go to step C.



C Using jumper, connect wires 509E together. If parking brake warning light comes on, adjust or replace parking brake warning switch (ref. p. 8-66). If parking brake warning light fails to light, repair or replace wire 509E from switch to parking brake warning light.

TA472117

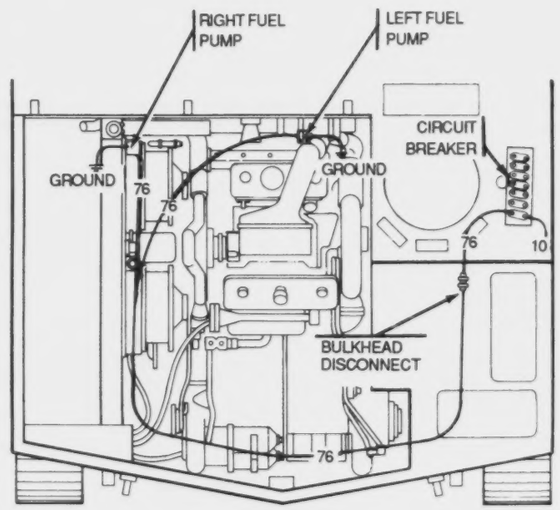
ELECTRIC FUEL PUMP (M109A2/M109A3)	ENGINE MISSES WHEN LOW ON FUEL. One or both fuel pumps are not operating.

Troubleshoot electric fuel pump circuit.

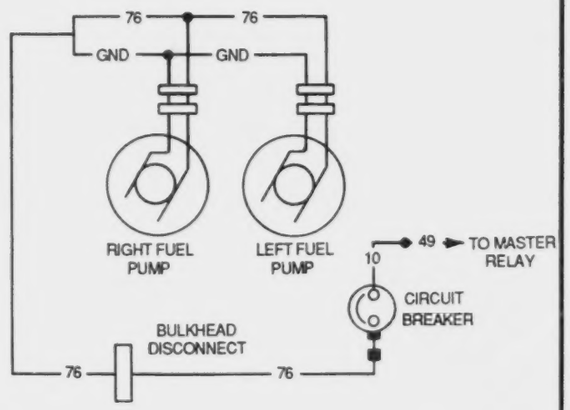
NOTE

Left fuel pump can be tested from driver's access door.

ELECTRIC FUEL PUMP CIRCUIT

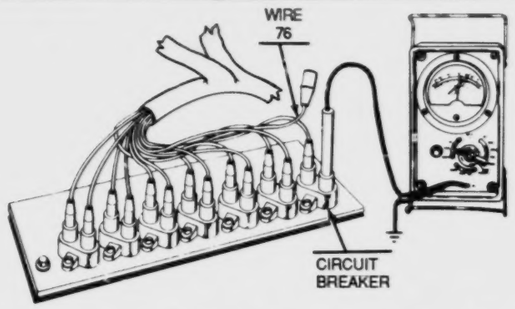


PICTORIAL VIEW

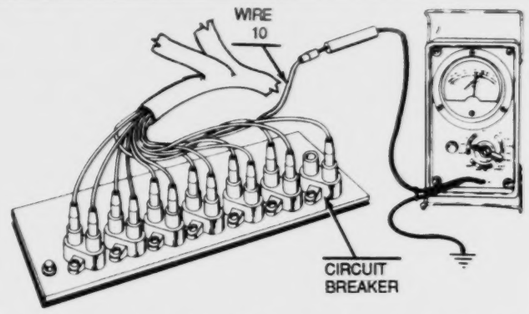


ELECTRICAL DIGRAM

TA472118

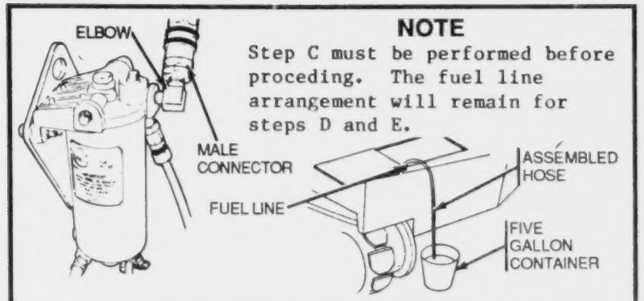


A Disconnect wire 76 from circuit breaker. Turn MASTER switch ON. Using multimeter set to dc volts scale, place red lead in circuit breaker output and ground black lead. If no voltage, go to step B. If voltage is present, go to step D.



B Disconnect wire 10 from circuit breaker. Turn MASTER switch ON. Place red multimeter lead in wire 10 and ground black lead. If voltage is present, replace circuit breaker (ref. p. 8-62). If no voltage, repair or replace wire 10 (ref. p. 8-100).

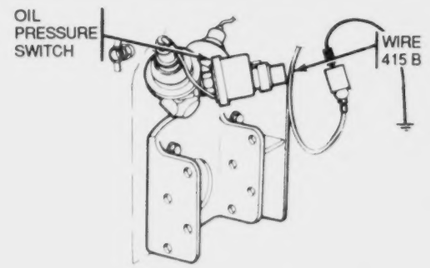
C Deleted



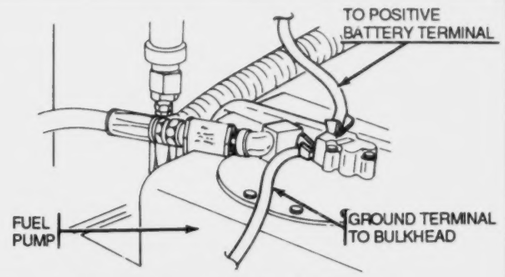
NOTE

Step C must be performed before proceding. The fuel line arrangement will remain for steps D and E.

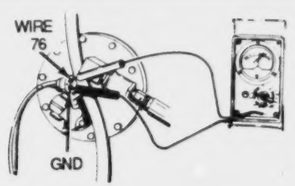
D Disconnect primary fuel filter at quick disconnect. Remove male portion of quick disconnect and elbow from fuel filter. Install on hose (Item 52, App. B). Connect assembled hose to fuel line and place other end in five gallon container to catch flowing fuel. Proceed to step E.



E Remove driver's access panel (ref. p. 11-20). Turn MASTER switch ON. Disconnect wire 76 from left fuel pump. Disconnect connector, wire 415B from engine oil pressure switch. Using jumper wire ground wire 415B and observe fuel flow. If fuel flows, proceed to step F. If fuel does not flow, go to step G.



F Disconnect connector at left fuel pump. Turn MASTER switch ON. Using jumper wires, connect ground terminal of fuel pump to bulkhead and positive terminal (connector 76) to positive battery terminal. Observe fuel flow. If fuel flows, repair or replace bulkhead to headlights/bilge pump wiring harness (ref. p. 8-77). If fuel does not flow, replace fuel pump (ref. p. 6-12).



G Remove powerplant (ref. p. 4-1). Disconnect connector at right fuel pump. Using jumper wire, ground wire 415B (socket B) of engine disconnect bracket to bulkhead wiring harness (at engine bracket end). Place red multimeter lead in connector, wire 76, and black to GND connector. With MASTER switch ON, check for voltage. If voltage is present, replace fuel pump (ref. p. 6-12). If voltage is not present, repair or replace bulkhead to headlights/ bilge pump wiring harness (ref. p. 8-77).

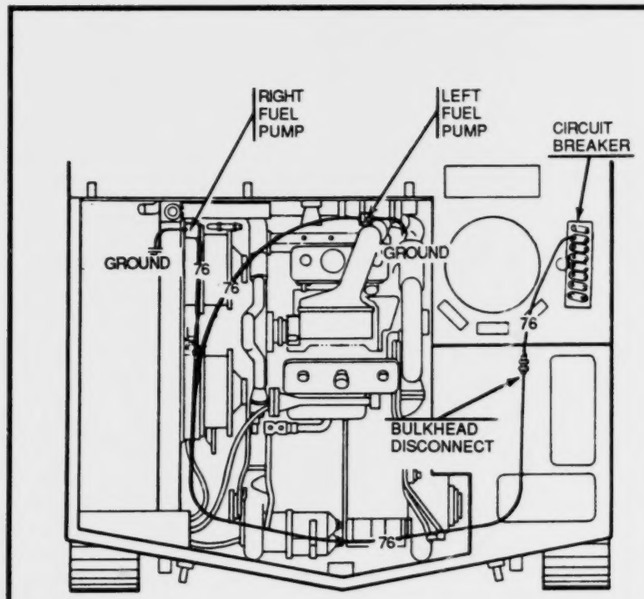
ELECTRIC FUEL PUMP (M109A4)	ENGINE MISSES WHEN LOW ON FUEL. One or both fuel pumps are not operating.

Troubleshoot electric fuel pump circuit.

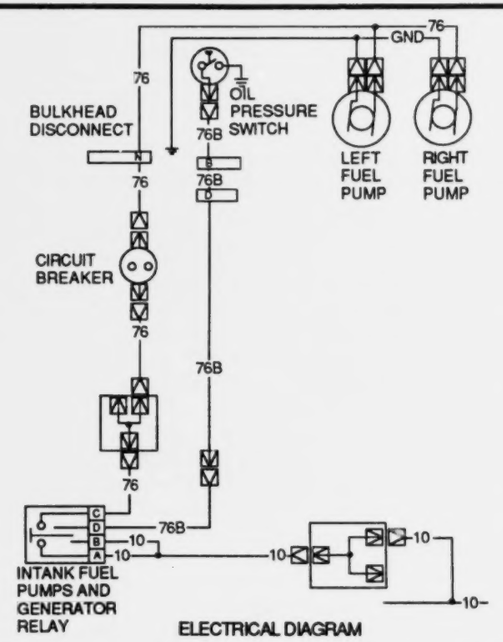
NOTE

Left fuel pump can be tested from driver's access door.

ELECTRIC FUEL PUMP CIRCUIT

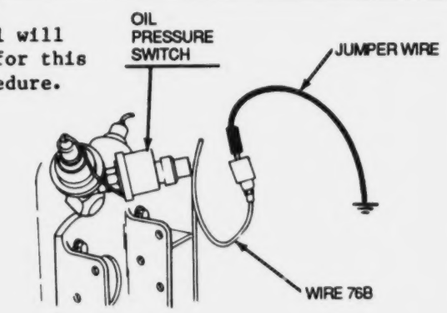


PICTORIAL VIEW

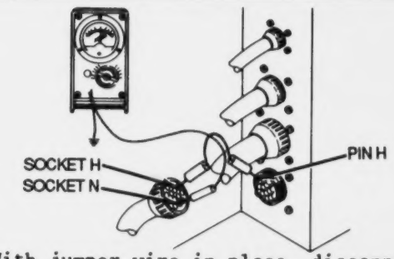


ELECTRICAL DIAGRAM

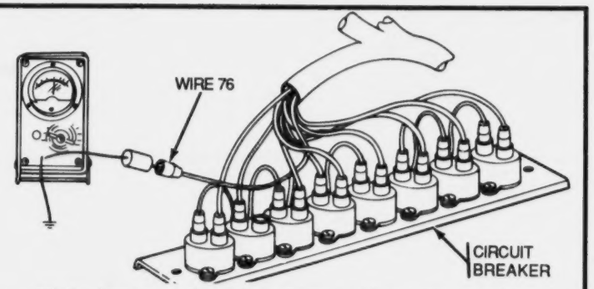
NOTE
Access panel will remain off for this entire procedure.



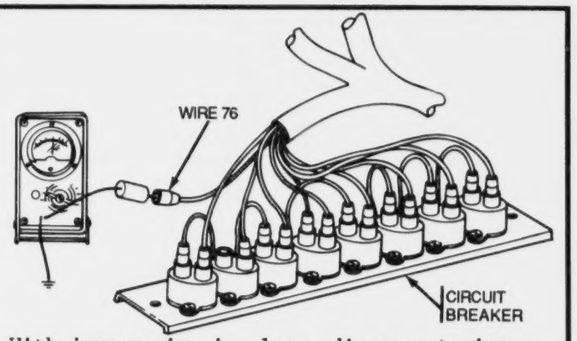
A Remove driver's access panel (ref. p. 11-20). Disconnect wire 76B at oil pressure switch. Using jumper wire, connect wire 76B to ground. Go to step B.



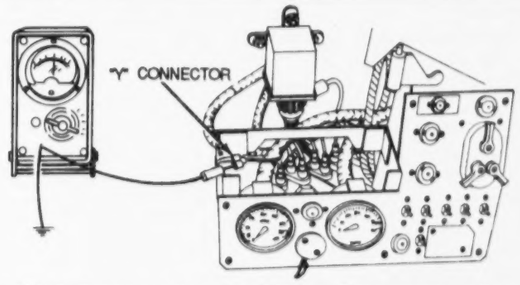
B With jumper wire in place, disconnect bulkhead to driver's instrument panel wiring harness at bulkhead. Using jumper wires, connect socket H to pin H. With MASTER switch ON, place red multimeter lead in socket N and black to ground. If voltage is not present, leave jumper wire in place and proceed to step C. If voltage is present, go to step O.



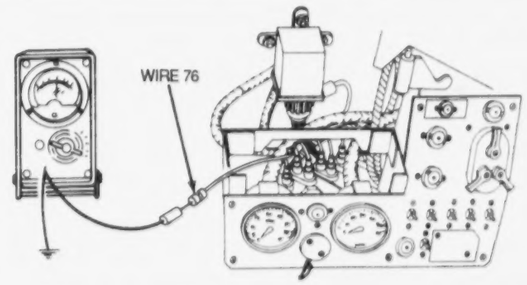
C With jumper wire in place, disconnect wire 76 from circuit breaker output. With MASTER switch ON, place red multimeter lead in circuit breaker and black lead to ground. Check for voltage. If voltage is present, repair bulkhead to driver's instrument panel wiring harness (ref. p. 8-87). If voltage is not present, connect driver's instrument panel wiring harness at bulkhead and go to step D.



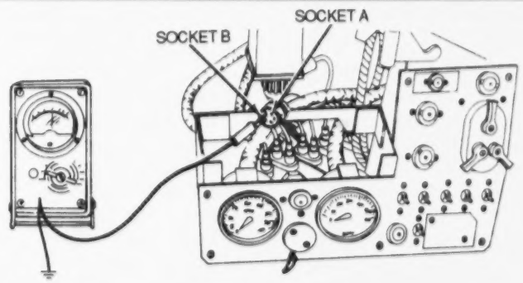
D With jumper wire in place, disconnect wire 76 from circuit breaker input. With MASTER switch ON, place red multimeter lead into connector, wire 76 and black to ground. Check for voltage. If voltage is present, replace circuit breaker (ref. p. 8-64). If no voltage is present, go to step E.



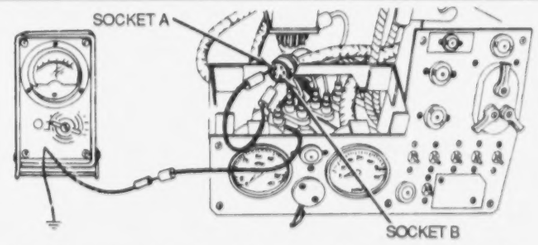
E With jumper wire in place, disconnect wire 76 at "Y" connector. With MASTER switch ON, place red multimeter lead in "Y" connector and black to ground. Check for voltage. If voltage is present, replace wire 76 to circuit breaker (ref. p. 8-134). If voltage is not present, go to step F.



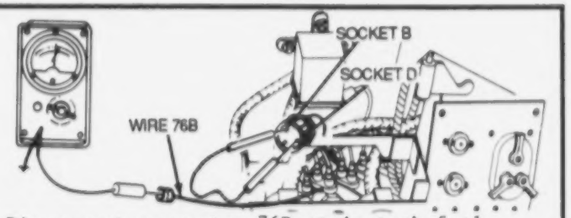
F With jumper wire in place, disconnect wire 76 at "Y" connector. With MASTER switch ON, place red multimeter lead in wire 76 and black to ground. Test for voltage. If voltage is present, replace "Y" connector. If voltage is not present, go to step G.



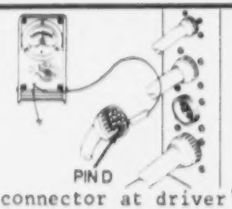
G Disconnect connector at fuel pump system relay. With MASTER switch ON, place red multimeter lead in socket A and black to ground. Test for voltage. Place red multimeter lead in socket B and check for voltage. If voltage is present at both sockets, go to step H. If voltage is not present at either socket, go to step M.



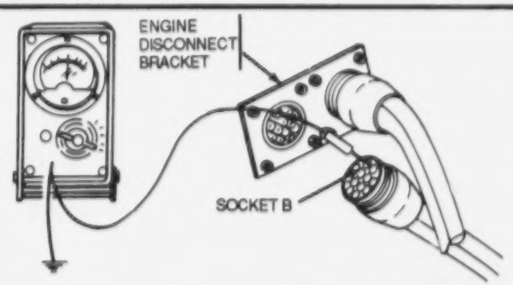
H Disconnect wire 76 at "Y" connector and connector at fuel pump system relay. Using jumper wire, connect socket A and C at fuel pump system relay. With MASTER switch ON, place red multimeter lead in connector, wire 76 and black to ground. Check for voltage. If voltage is present, go to step I. If voltage is not present, repair or replace the in-tank fuel pump lead assembly (ref. p. 8-132.2).



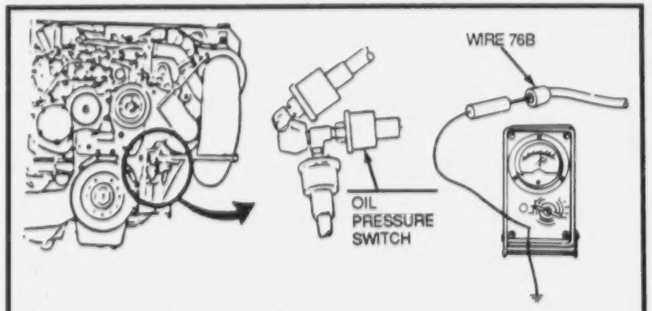
I Disconnect connector 76B at in-tank fuel pump lead assembly and the in-tank fuel pump lead assembly at the relay. Using jumper wire, connect socket B and socket D. With MASTER switch ON, place red multimeter lead in connector 76B and black to ground. Check for voltage, if voltage is present, leave jumper wire in place and go to step J. If voltage is not present, repair or replace the in-tank fuel pump lead assembly (ref. p. 8-132.2).



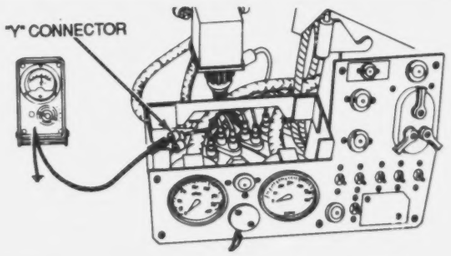
J Disconnect connector at driver's bulkhead. Using jumper wires, connect pin B to socket B. With jumper wire in place at (wire 76B) in-tank fuel pump lead assembly at the relay, and MASTER switch ON, place red multimeter lead in pin D and black to ground. Check for voltage. If voltage is present, leave jumper wire in place at in-tank fuel pump lead assembly at relay, attach connector at driver's bulkhead, and go to step K. If voltage is not present, repair bulkhead to portable instrument panel wiring harness (ref. p. 8-84).



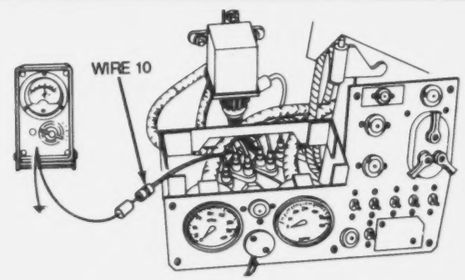
K Disconnect connector at engine disconnect bracket. With jumper wire in place and MASTER switch ON, place red multimeter lead in socket B and black to ground. Check for voltage. If voltage is present, leave jumper wire in place and go to step L. If voltage is not present, repair driver's bulkhead to master relay wiring harness (ref. p. 8-76.1).



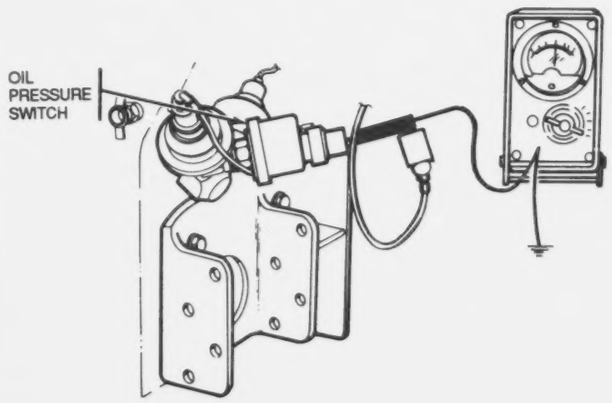
L Disconnect wire 76B at oil pressure switch. With jumper wire in place and MASTER switch ON, place red multimeter lead in socket, wire 76B and black to ground. If voltage is not present, replace powerplant wiring harness (ref. p. 8-74). If voltage is present, replace in-tank fuel pump system relay (ref. p. 8-64.2).



M Disconnect connector, wire 10 at "Y" connector. With MASTER switch ON, place red multimeter lead in "Y" connector and black to ground. Check for voltage. If voltage is present, replace or repair the in-tank fuel pump lead assembly (ref. p. 8-132.2).If voltage is not present, go to step N.

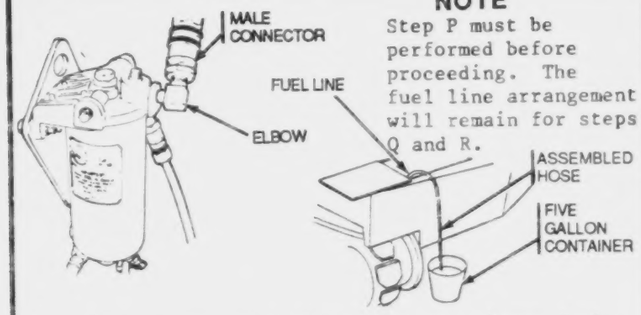


N Disconnect connector, wire 10 at "Y" connector. With MASTER switch ON, place red multimeter lead in wire 10 connector and black to ground. Test for voltage. If voltage is present, replace "Y" connector. If voltage is not present, repair power lead (ref. p. 8-106).

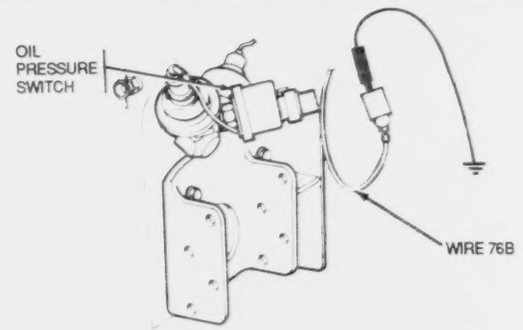


O Start vehicle engine. After oil pressure builds to operating range (ref. TM 9-2350-311-10), place red multimeter lead in oil pressure switch connector and black to ground. Test for continuity. Shut down engine. If switch was closed (continuous), go to step P. If switch was open, replace (ref. p. 8-13).

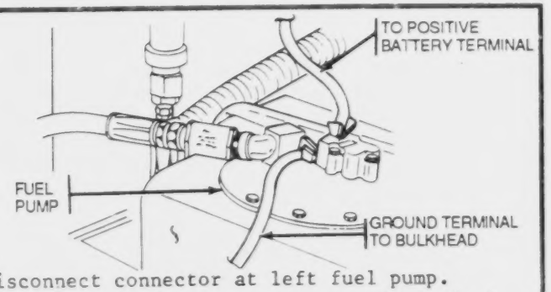
NOTE
Step P must be performed before proceeding. The fuel line arrangement will remain for steps Q and R.



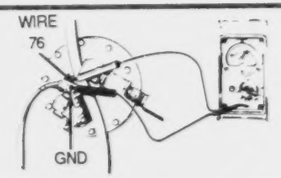
P Disconnect quick disconnect at primary fuel filter. Remove male portion of quick disconnect and elbow from fuel filter. Install on hose (Item 52, App. B). Connect assembled hose to fuel line and place other end in five gallon container to catch flowing fuel. Proceed to step Q.



Q Disconnect wire 76 from left fuel pump. Disconnect connector, wire 76B from engine oil pressure switch. Using jumper wire ground wire 76B. Turn MASTER switch ON, and observe fuel flow. If fuel flows proceed to step R. If fuel does not flow, go to step S.



R Disconnect connector at left fuel pump. Using jumper wires, connect ground terminal of fuel pump to bulkhead and positive termianl (connector 76) to positive battery terminal. Turn MASTER switch ON and observe fuel flow. If fuel flows, repair or replace bulkhead to headlights/bilge pump wiring harness (ref. p. 8-77). If fuel does not flow, replace fuel pump (ref. p. 6-12).

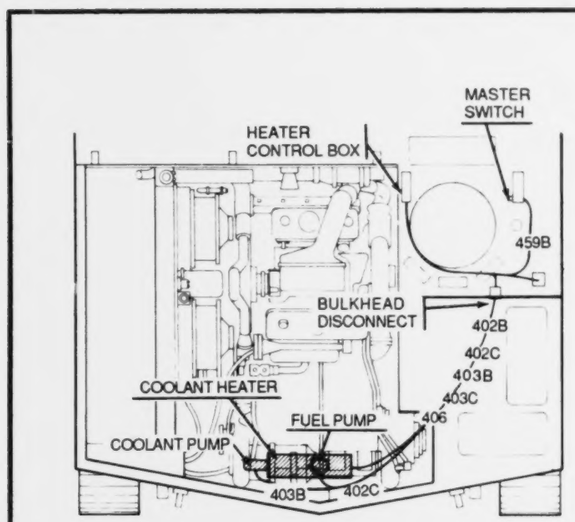


S Remove powerplant (ref. p. 4-1). Disconnect connector at right fuel pump. Using jumper wire, ground wire 76B (socket B) of engine disconnect bracket to bulkhead wiring harness (at engine bracket end). Place red multimeter lead in connector, wire 76, and black to GND connector. With MASTER switch ON, check for voltage. If voltage is present, replace fuel pump (ref. p. 6-12). If voltage is not present, repair or replace bulkhead to headlights/ bilge pump wiring harness (ref. p. 8-77).

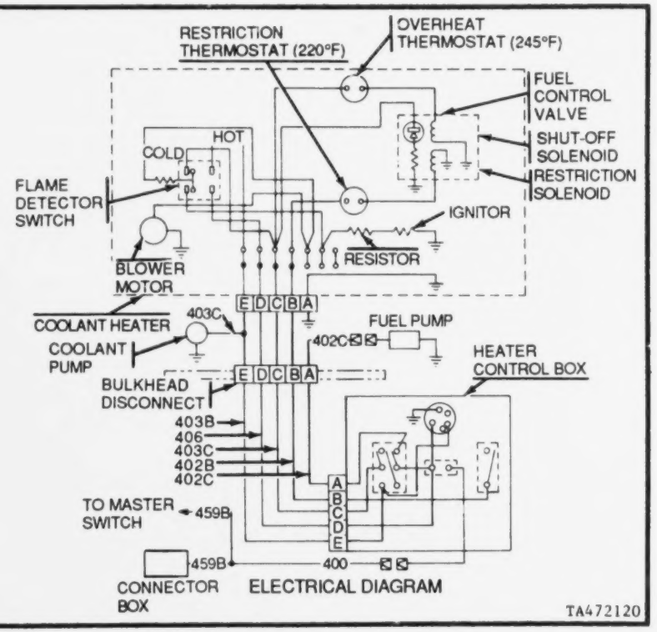
WINTERIZATION KIT	COOLANT HEATER DOESN'T OPERATE. Do steps A through D. HEATER BLOWER OPERATES, BUT MOTOR DOESN'T OPERATE. Do steps E and F. HEATER MOTOR OVERHEATS. Do step G.

Troubleshoot winterization kit circuit.

WINTERIZATION KIT CIRCUIT

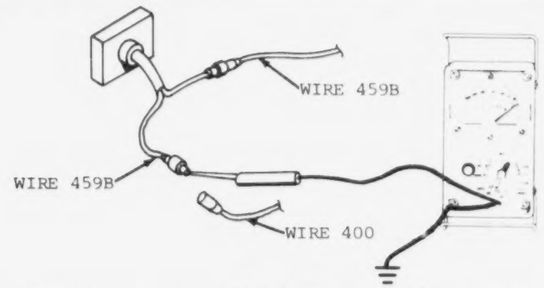


PICTORIAL VIEW

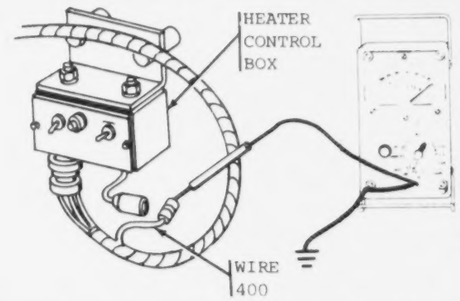


ELECTRICAL DIAGRAM

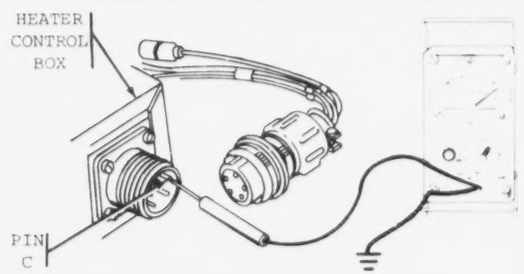
TA472120



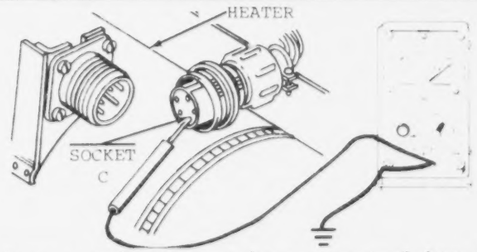
A Disconnect wire 459B from wire 400. Place red lead of multimeter in wire 459B connector and black lead to ground. Turn MASTER switch ON. Check for voltage. If no voltage, troubleshoot master relay circuit (ref. p. 3-13). If voltage is present, go to step B.



B Disconnect wire 400 from heater control box. Place red multimeter lead in wire 400 and ground black lead. Turn MASTER switch ON. If no voltage, repair or replace wire 400 (ref. p. 13-12). If voltage is present, reconnect wire 400 and go to step C.

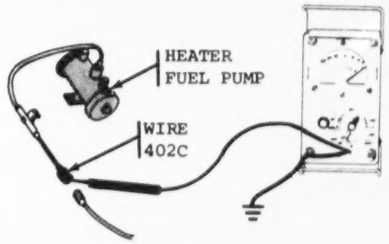


C Disconnect connector from heater control box. Turn MASTER switch ON. Place red multimeter lead on pin C and ground black lead. Move heater control switch to START position. If no voltage, replace heater control box (ref. p. 13-15). If voltage is present, go to step D.

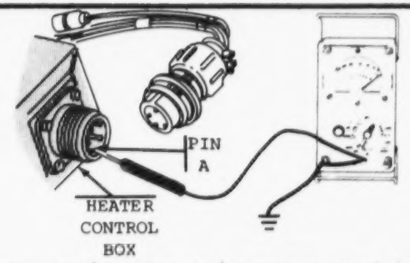


D Reconnect harness at heater control box and disconnect harness at coolant heater. Turn MASTER switch ON. Place red multimeter lead in socket C of harness and ground black lead. Move heater control switch to the START position. If voltage is present, replace heater (ref. p. 13-9). If no voltage, repair or replace wire 403C (ref. p. 13-12).

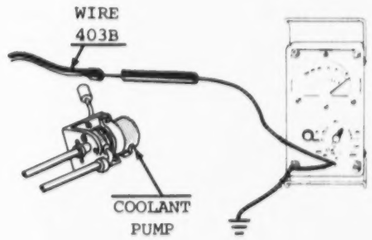
TA472121



E With MASTER switch ON, disconnect wire 402C at heater fuel pump. Place red multimeter lead in wire 402 C from harness and ground black lead. Move heater control switch to START position and then to LOW position. If voltage is present in both positions, replace fuel pump (ref. p. 13-7). If no voltage, go to step F.



F Disconnect harness at heater control box. With MASTER switch ON, place red multimeter lead on pin A of heater control box and ground black lead. Move heater control switch to START position and then to LOW position. If voltage is present in both positions, repair or replace wire 402C (ref. p. 13-12). If no voltage in both positions, replace heater control box.



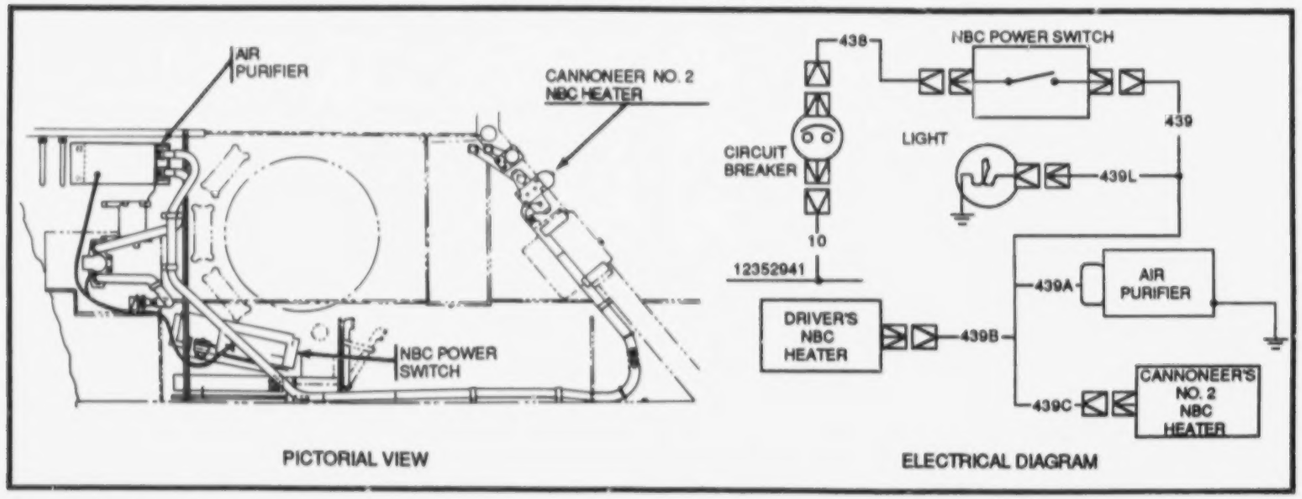
G Disconnect wire 403B from coolant pump. Turn MASTER switch ON. Start heater. When heater indicator light comes on, move heater control switch to LOW position. Place red multimeter lead in wire 403B and ground black lead. If no voltage, repair wire 403B (ref. p. 13-12). If voltage is present, replace coolant pump (ref. p. 13-6).

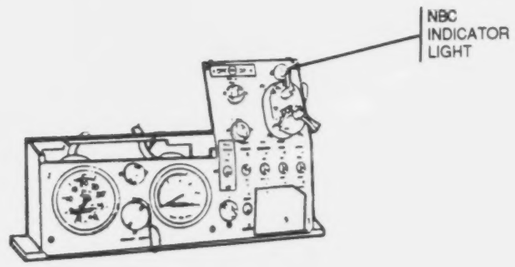
TA472122

VENTILATED FACE PIECE SYSTEM (M109A4)	NBC INDICATOR LIGHT DOES NOT ILLUMINATE. Do steps A and B. AIR PURIFIER, DRIVER'S AND CANNONEER NO.2 HEATERS DON'T OPERATE. Do steps C through F. PURIFIER DOES NOT OPERATE. Do steps G through H. DRIVER'S HEATER DOES NOT OPERATE. Do step I. CANNONEER NO. 2 HEATER DOES NOT OPERATE Do step J.

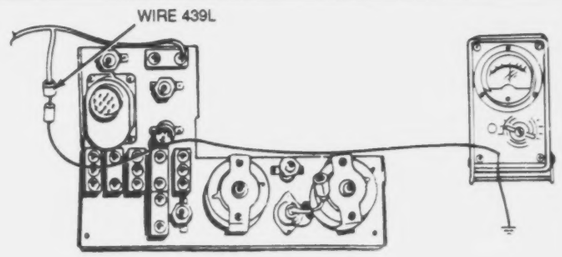
Troubleshoot ventilated face piece system circuit.

VENTILATED FACE PIECE SYSTEM

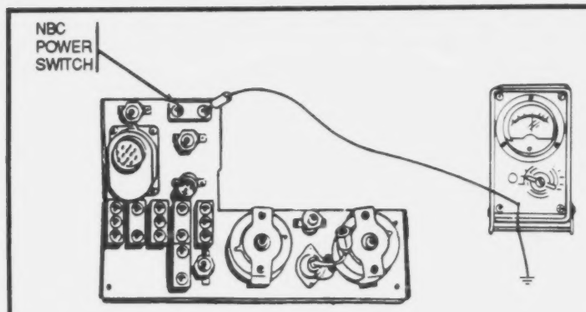




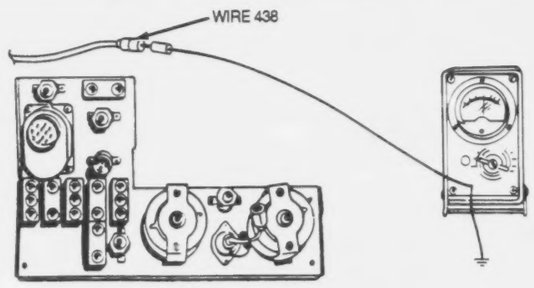
A Verify that indicator light bulb is not burned out. If bulb is bad, replace. If bulb is good, go to step B.



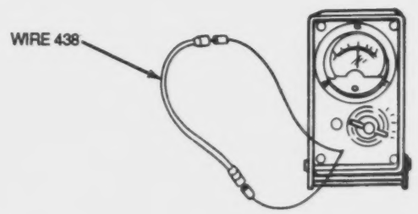
B Disconnect wire 439L from NBC indicator light. Set multimeter to dc volts scale. With MASTER and NBC power switches ON place red lead to wire 439L and black lead to ground. If voltage is present, replace NBC indicator light. If voltage is not present, repair wire 439L (ref. p. 8-116.6).



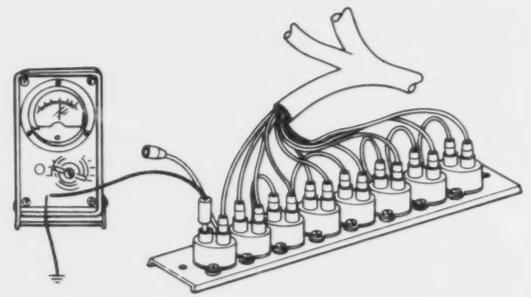
C Disconnect wire 439 at NBC power switch. With MASTER and NBC switches ON place red lead in switch socket and black lead to ground. Check for voltage. If there is no voltage, go to step D. If voltage is present, repair wire 439 (ref. p. 8-116.6).



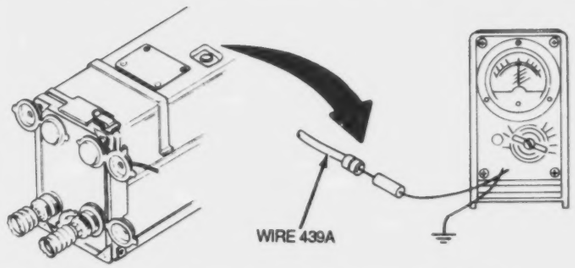
D Disconnect wire 438 from NBC power switch. With MASTER switch ON place red lead of multimeter in connector wire 438 and black lead to ground. Check for voltage. If there is voltage replace NBC power switch (ref. p. 8-22). If there is no voltage, go to step E.



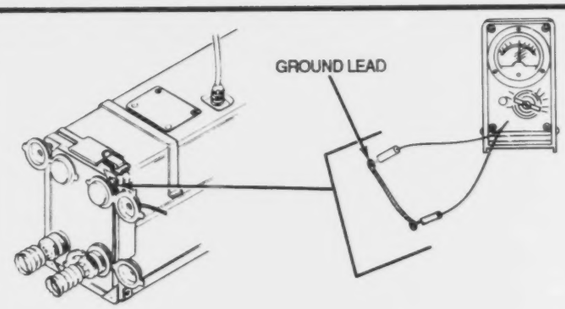
E Disconnect wire 438 from circuit breaker. Measure continuity of wire 438 by placing a multimeter lead at each end. If there is no continuity, replace wire 438 (ref. p. 8-144). If there is continuity, go to step F.



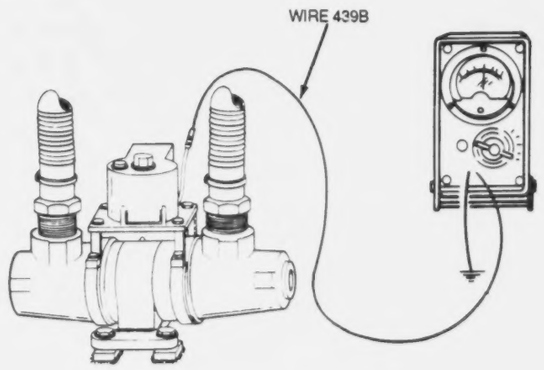
F Disconnect wire 10 and place red lead in connector, wire 10 and black lead to ground. Check for voltage at circuit breaker. If there is voltage, replace circuit breaker (ref. p. 8-64). If voltage is not present, repair or replace wire 10 (ref. p. 8-106).



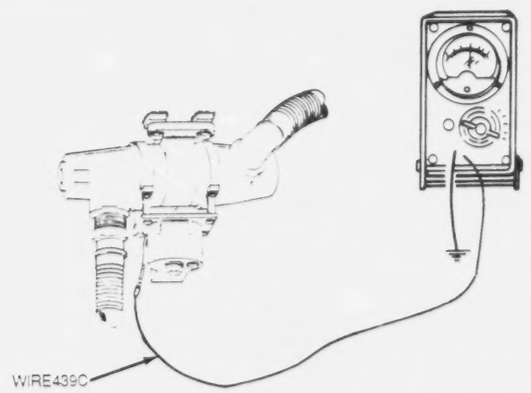
G Disconnect wire 439A from air purifier. Set multimeter to dc volts scale and with MASTER and NBC power switches ON place red lead in wire connector and black lead to ground. If voltage is not present, repair or replace wire 439A (ref. p. 8-116.6). If voltage is present, go to step H.



H Set multimeter to ohms scale. Place leads on each end of ground lead and check for continuity. If there is no continuity, replace ground lead (ref. p. 11-68). If there is continuity, replace the air purifier.



I Disconnect wire 439B from the driver's heater. Set multimeter to dc volts scale. With MASTER and NBC power switches ON place red lead to wire 439B and black to ground. If no voltage is present, replace wire 439B (ref. p. 8-116.6). If voltage is present, repair or replace driver's heater (ref. p. 11-75).

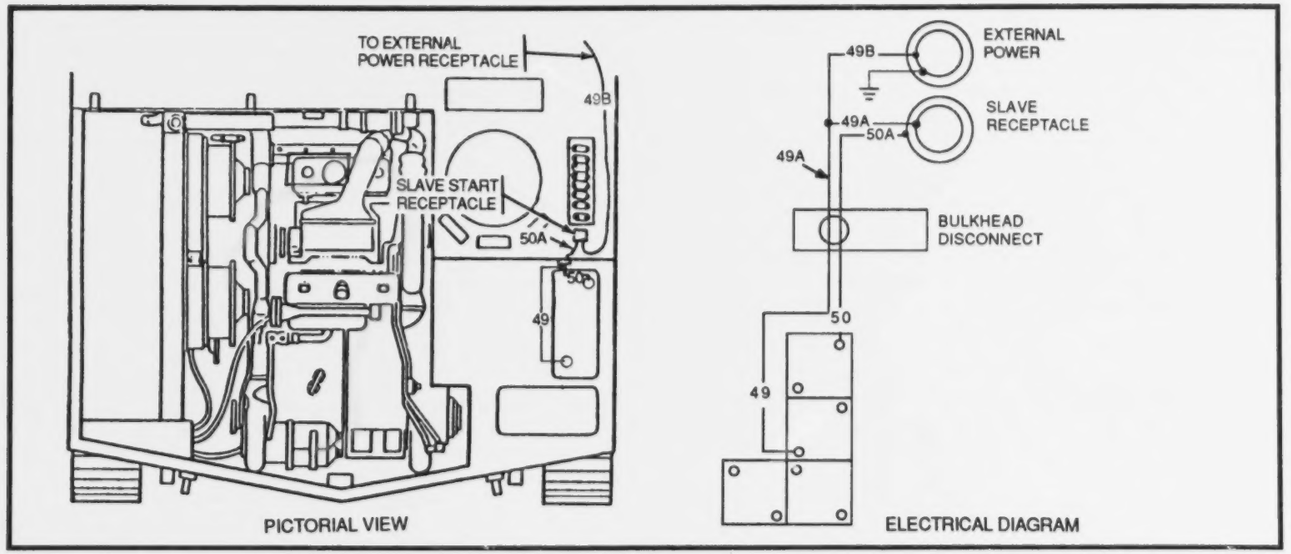


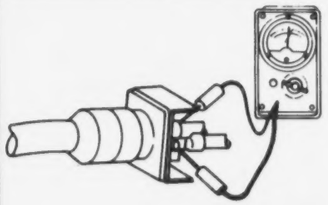
J Disconnect wire 439C from the cannoneer No. 2's heater. Set multimeter to dc volts scale and turn MASTER and NBC power switches ON. Place red multimeter lead to wire 439C and black lead to ground. If no voltage is present, replace or repair wire 439C (ref. p. 8-116.6). If voltage is present, replace cannoneer No. 2's heater (ref. p. 11-75).

SLAVE START/ EXTERNAL POWER RECEPTACLE (M109A4)	SLAVE START DOESN'T OPERATE. Do steps A and B. EXTERNAL POWER RECEPTACLE DOESN'T OPERATE. Do steps C and D.

Troubleshoot slave start/external power circuit.

SLAVE START/EXTERNAL POWER CIRCUIT

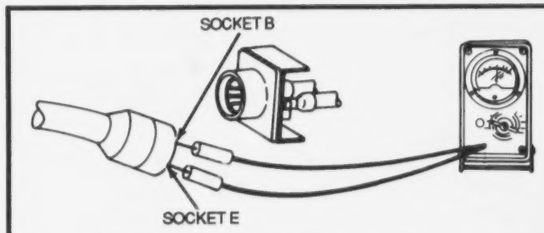




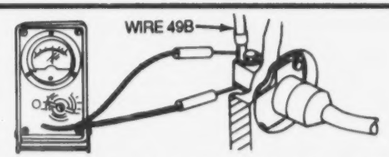
NOTE

Batteries must be disconnected for all of the following steps to prevent inaccurate voltage measurements.

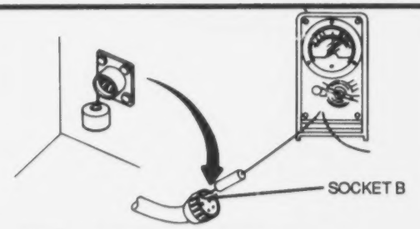
A Disconnect batteries (ref. p. 8-56) and leave disconnected for steps A and B. Using an external power source, apply 24 Vdc at slave start receptacle. Place red multimeter lead at wire 49A connection at slave start and black to wire 50A connection. Check for voltage. If voltage is present, leave external power applied and go to step B. If voltage is not present, replace slave start receptacle (ref. p. 8-68).



B Disconnect NATO slave to external power wiring harness at driver's bulkhead. With external power still applied place red multimeter lead in socket B and black lead to socket E. Check for voltage. If voltage is present, repair or replace driver's bulkhead to batteries lead assembly (ref. p. 8-146). If voltage is not present, repair or replace NATO slave to external power wiring harness (ref. p. 8-116.8).



C Remove external power receptacle guard (ref. p. 8-68.1). Disconnect batteries (ref. p. 8-56) and leave disconnected for steps C and D. Using external power source, apply 24 Vdc at external power receptacle. Place red multimeter lead on wire 49B connection and black lead to bus bar connection at external power receptacle. Check for voltage. If voltage is present, leave external power source attached and go to step D. If voltage is not present, replace external power receptacle (ref. p. 8-68.1).



D Disconnect NATO slave to external power wiring harness at driver's bulkhead. Place red multimeter lead in socket B and black lead to ground. Check for voltage. If voltage is present, repair or replace driver's bulkhead to batteries lead assembly (ref. p. 8-146). If no voltage is present, repair or replace NATO slave to external power wiring harness (ref. p. 8-116.8).

CHAPTER 4
POWERPLANT

GENERAL

This chapter illustrates the removal and installation of the powerplant consisting of the engine, transfer case and transmission assemblies, and related accessories. Procedures for operating the powerplant after removal from the vehicle are also given.

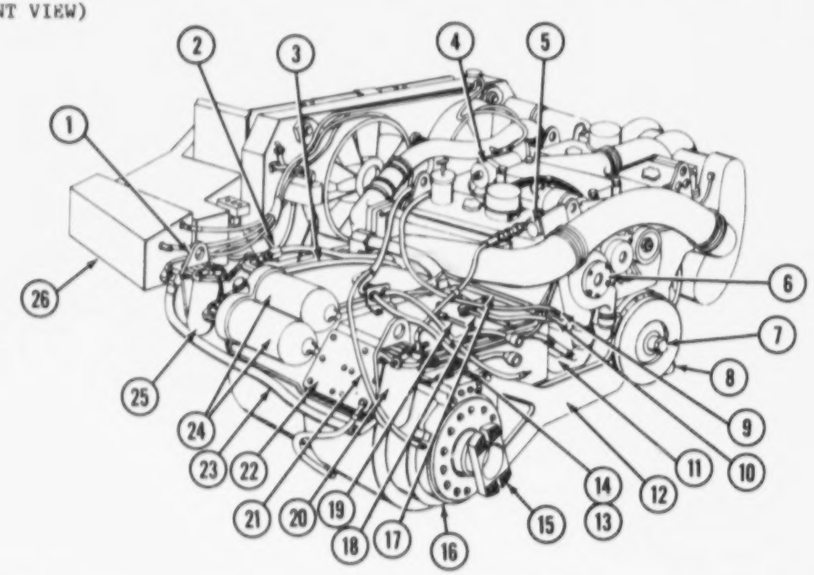
The powerplant shall be given periodic checks to find possible fire hazards. Inspections for foreign matter shall be performed on the powerplant cooling accessories, air shrouding, wiring, and powerplant hull compartment during each maintenance service.

Whenever the powerplant is removed for maintenance the powerplant should be given a general cleaning and inspection of wiring, hoses and piping.

POWERPLANT (LEFT FRONT VIEW)

NOTE

Location of primary fuel filter differs in the M109A2 and M109A3 (ref. p. 6-14).



LEGEND

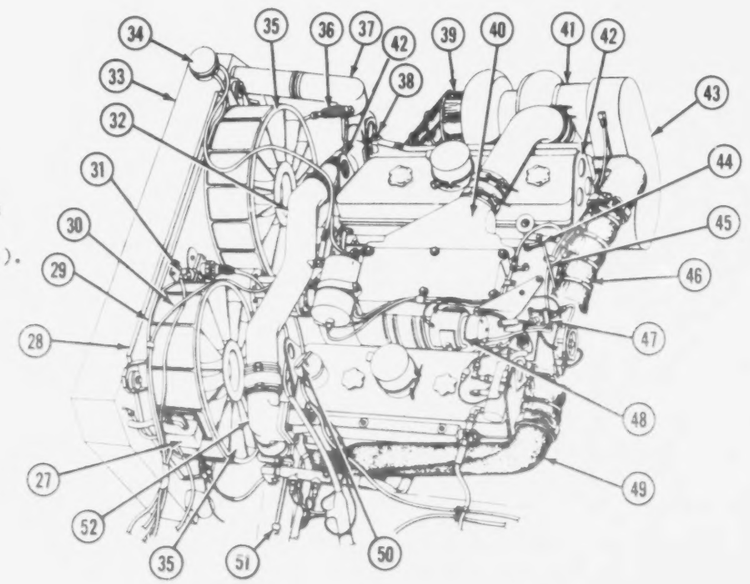
1. Transmission lifting eye
2. Engine oil filter to oil cooler hose
3. Engine oil cooler to filter hose
4. Flame heater igniter
5. Electric fuel pump
6. Coolant pump
7. Engine viscous vibration damper
8. Oil pan
9. Tachometer drive shaft
10. Speedometer drive shaft
11. Engine coolant inlet tube
12. Engine and transmission support
13. Brake apply lever - right
14. Brake apply lever - left
15. Universal joint flange adapter
16. Transmission
17. Transmission throttle valve rod
18. Transmission steer control rod
19. Transmission shift control rod
20. Secondary fuel filter
21. Alternator-to-rectifier wiring harness
22. Transmission inspection cover (brake adjustment)
23. Surge tank to coolant pump tube
24. Engine oil filters
25. Primary fuel filter
26. Coolant surge tank

TA472123

POWERPLANT (TOP VIEW)

NOTE

Location of surge tank pressure relief valve differs in the M109A2/M109A3 and M109A4 vehicles (ref. p. 7-26).



27. Aeration detector
28. Radiator cooling fan shroud
29. Radiator to surge tank hose
30. Crossover tube-to-surge tank hose
31. Surge tank pressure relief valve
32. Crossover tube
33. Radiator
34. Radiator filler cap
35. Radiator cooling fans
36. Fuel return line quick disconnect
37. Inlet thermostat housing
38. Engine coolant temperature transmitter
39. Engine exhaust outlet duct
40. Engine blower inlet housing
41. Turbocharger
42. Engine lifting eye
43. Engine turbocharger inlet duct
44. Engine governor
45. Engine governor throttle control rod
46. Exhaust crossover tube
47. Air box heater fuel pump solenoid valve
48. Air box heater motor and pump assembly
49. Engine exhaust manifold - right
50. Engine oil filler cap
51. Transfer breather tube
52. Bypass thermostat housing

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POWERPLANT

This task covers:

a. Removal b. Inspection c. Special equipment hook-ups d. Test run
e. Special equipment removal f. Installation

INITIAL SET-UP

Materials/Parts
Packing - Exhaust deflector
Cotter pins (6)
Lockwire (as required)

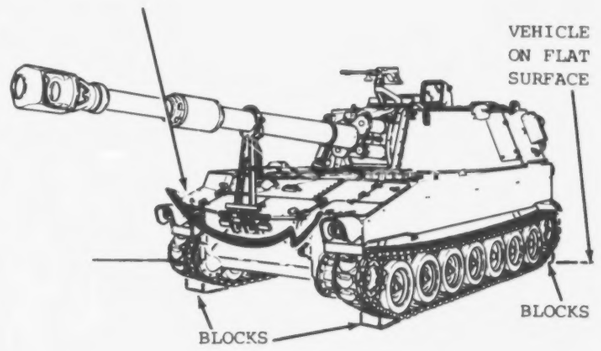
Personnel Required
3

Tools
Automotive Maintenance
Common No. 2 Tool Kit
SC 4910-95-CL-A72

Special Tools
Adapter (Item 24, App. B)
Starter electrical lead (Item 25, App. B)
Ground cable - M109A2/M109A3 (Item 26, App. B)
Power cable - M109A4 (starter circuit) (Item 26.1, App. B)
Power cable - M109A2/M109A3 (rectifier to alternator) (Item 27, App. B)
Power cable - M109A4 (rectifier to alternator) (Item 27.1, App. B)
Power cable (starter and master warning circuit) (Item 28, App. B)
Quick-disconnect (Item 29, App. B)
Hose assembly (Item 30, App. B)
Safety screen (Item 31, App. B)
Lifting sling (Item 32, App. B)
Stall check kit (Item 33, App. B)
Socket wrench (Item 34, App. B)

a. Removal

1 Check the equipment to be used to remove the powerplant unit. It must have a lifting capacity of at least 7500 pounds (3402 Kgm), reach at least 9 feet (2.7M), and lift at least 10 feet (3M). It should be movable, or provisions must be made to move the vehicle as the powerplant is removed.



2 Provide an area 8 feet by 10 feet (2.4M by 3.0M) near the track for the powerplant after removal.

3 Provide a stand or frame to hold the powerplant after removal. If unavailable, set the powerplant on wood blocks (ref. p. 4-23).

CAUTION

Track must be blocked so that the vehicle will not roll out of control. When the powerplant is disconnected, the vehicle is without brakes.

4 Move vehicle to level surface. Secure with blocks under tracks.

5 Release and stow travel lock.

6 Traverse the tube so that it is at right angles to the side of the hull.

7 Place MASTER switch in OFF position.

8 Disconnect both battery ground straps (ref. p. 8-56).

9 Release parking brake. Place transmission in R2. Move steering wheel to right position.

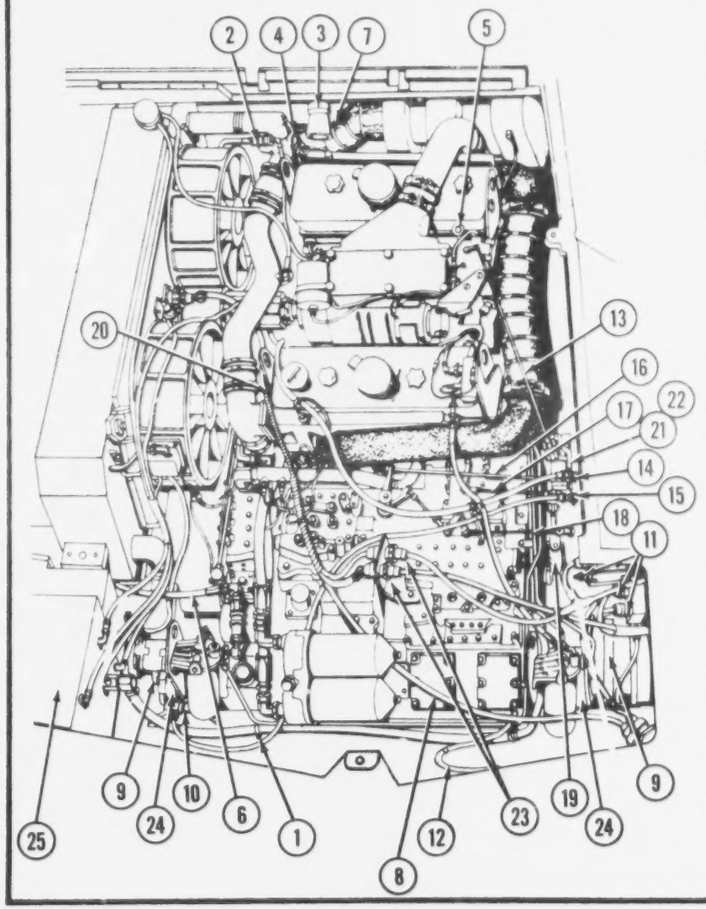
10 Move throttle to idle position so it is easier to disconnect throttle linkage.

TA472125

NOTE

M109A2/M109A3 pictured.

M109A4 Powerplant ground cable located at starter.

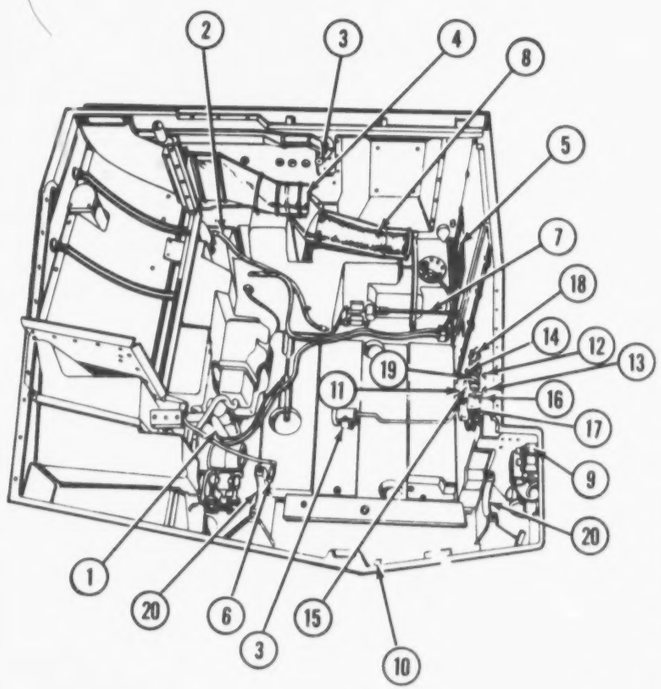


POWERPLANT DISCONNECT POINTS IN HULL (POWERPLANT IN VEHICLE)

1. Coolant pump-to-surge tank hose clamps
2. Engine-to-lower fuel tank return hose and clamp
3. Fixed fire extinguisher nozzle
4. Engine exhaust pipe flanges
5. Governor fuel shutoff lever, pulley, and cable
6. Primary fuel filter input hose
7. Air cleaner duct hose at turbocharger inlet
8. Alternator-to-rectifier harness (at rectifier)
9. Final drive universal joints
10. Speedometer right angle rod
11. Master relay and voltage regulator disconnects
12. Powerplant ground cable (M109A2/M109A3 Only)
13. Throttle governor control rod
14. Tachometer flexible drive shaft
15. Speedometer flexible drive shaft
16. Throttle governor control rod (linkage)
17. Steer control rod
18. Shift control rod
19. Brake control sprocket, shaft and pin
20. Separation of starter cable and generator-to-rectifier harness
21. Throttle control tube
22. Accelerator and throttle control bracket
23. Engine starter cable and master circuit harness
24. Transmission support caps
25. Coolant surge tank, retainer and pad

TA472126

POWERPLANT DISCONNECT POINTS
(POWERPLANT OUT OF VEHICLE)



NOTE

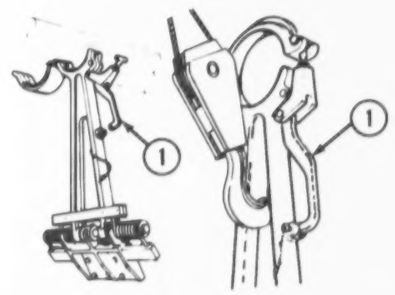
For information on the disconnect points of the winterization kit, ref. p. 13-2.

1. Bilge pump hose and tube (ref. page 11-48)
2. Engine-to-lower fuel tank return hose
3. Fixed fire extinguisher nozzle
4. Engine exhaust pipe flanges
5. Engine compartment access door
6. Primary fuel filter input hose
7. Engine mount release shaft
8. Air cleaner duct hose
9. Master relay and voltage regulator
10. Powerplant ground cable terminal (M109A2/M109A3)
11. Throttle governor control rod
12. Tachometer flexible drive shaft
13. Speedometer flexible drive shaft
14. Throttle valve control rod (linkage)
15. Steer control rod
16. Shift control rod
17. Brake control sprocket and shaft
18. Throttle control tube
19. Accelerator and throttle control bracket
20. Transmission support caps

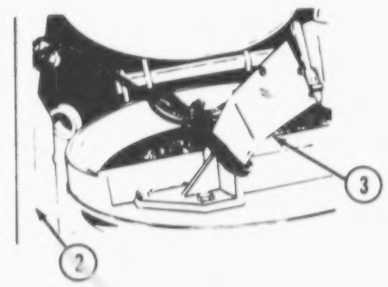
TA472127

POWERPLANT - CONTINUED

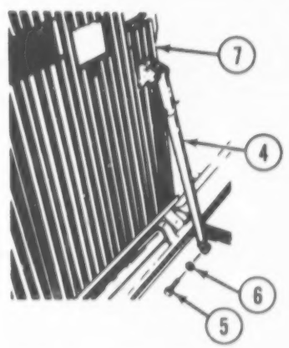
a. Removal - Continued



11 Remove travel lock (1) (ref. p. 11-32).

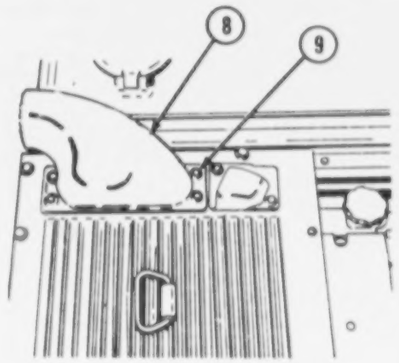


12 Open air intake grille (2) and secure to machine-gun pintle mount (3) with rope/strap.

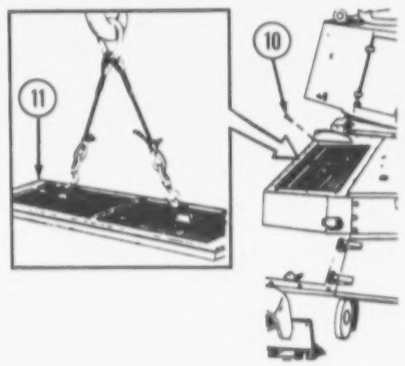


13 Remove air intake grille hold-open support arm (4) by taking out screw (5), flatwasher (6) and support arm pin (7).

TA472128



14 Remove engine exhaust deflector (8) by removing four screws (9). Remove and discard packing from exhaust deflector seat.



WARNING

Keep clear of equipment when it is being raised or lowered. To prevent injury, do not allow grilles or access doors to swing while suspended by lifting device.

NOTE

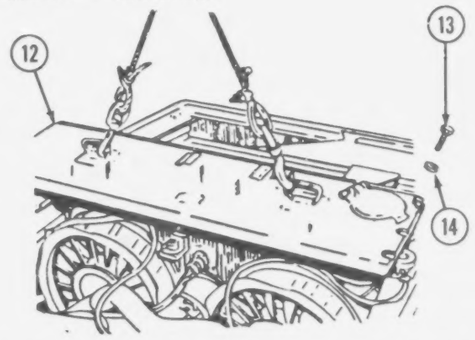
Each grille has different length screws. Keep screws with grille after removal.

15 Remove engine exhaust grille (10) by removing 14 screws (11).

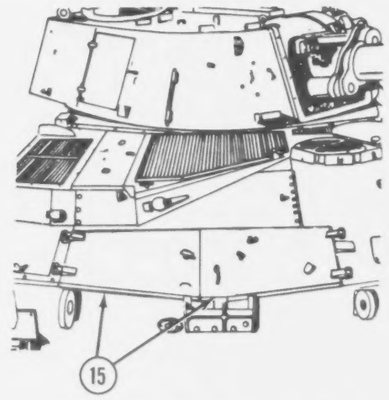
TA472129

POWERPLANT - CONTINUED

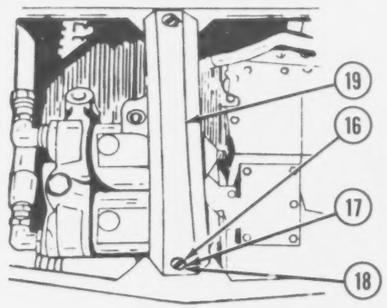
a. Removal - Continued



16 Remove radiator fan access door (12) by removing six screws (13) and six washers (14).



17 Open transmission access doors (15).



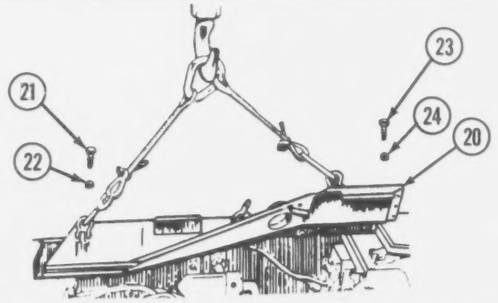
18 Remove lower screw (16), flatwasher (17) and hex nut (18) from transmission door support (19).

CAUTION

Support front slope plate to prevent equipment damage.

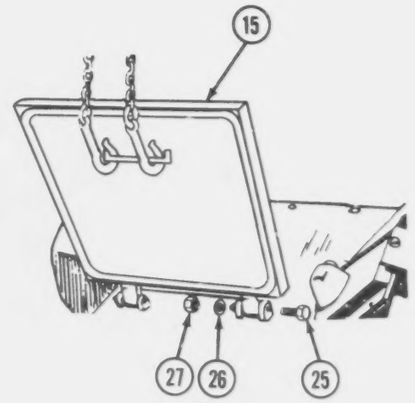
NOTE

If slope plate does not have lifting eyes, use transmission fill access hole.

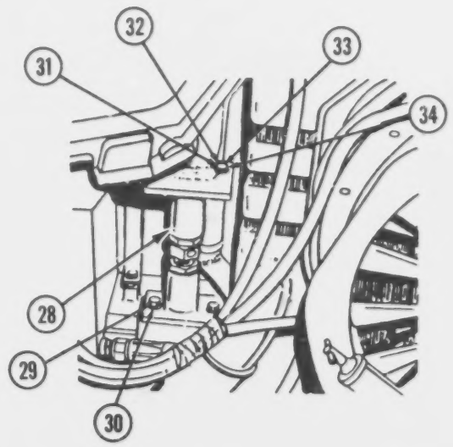


19 Remove center front slope plate assembly (20) by removing seven screws (21), seven washers (22), three screws (23) and three washers (24).

TA472130



20 Remove right transmission access door (15) by supporting at 45° angle and removing two screws (25), two washers (26) and two self-locking nuts (27). Remove left transmission access door by repeating the procedures.

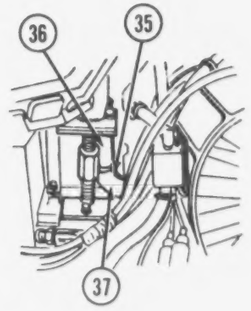


21 Remove grille support assembly (28) by removing two screws (29), two washers (30), two screws (31), four washers (32), two lockwashers (33), and two nuts (34).

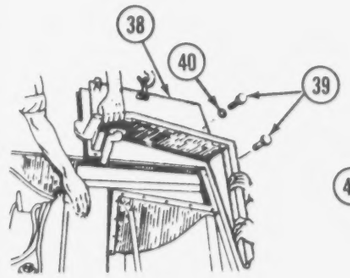
TA472131

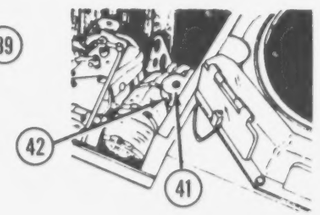
POWERPLANT - CONTINUED

a. Removal - Continued



22 Loosen hose clamp (35). Pull bilge pump hose (36) away from connector tube (37).



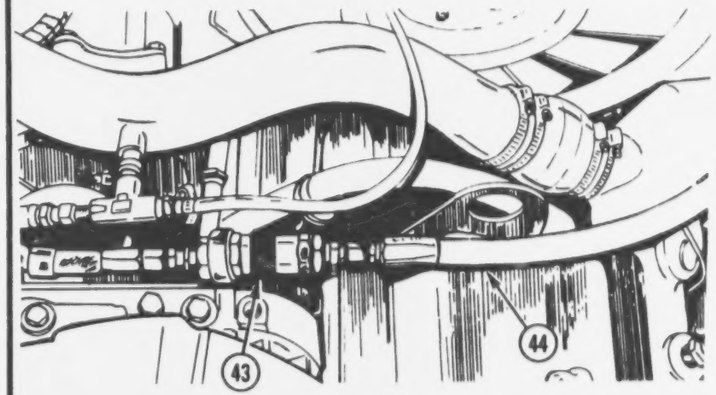


23 Remove right front grille assembly (38) by removing seven screws and six socket-head screws (39) and seven washers (40).

24 Remove air intake grille handle bracket (41) by removing two screws (42).

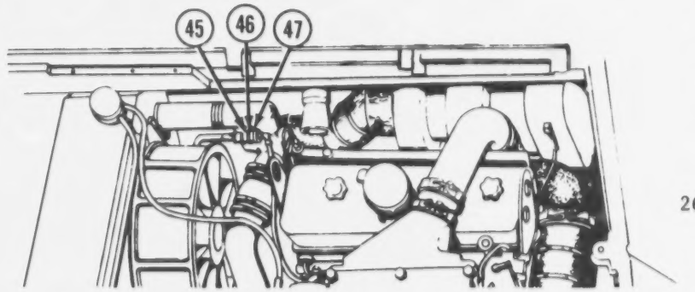
TA472132

M109A3 SHOWN



25 Disconnect quick-disconnect assembly (43) of engine-to-lower fuel tank return hose (44).

M109A2 SHOWN



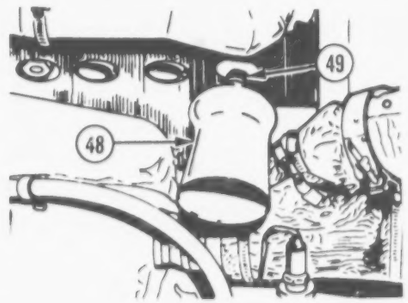
NOTE

Position of rubber coated clamp is the same for both the M109A2 and M109A3 vehicles.

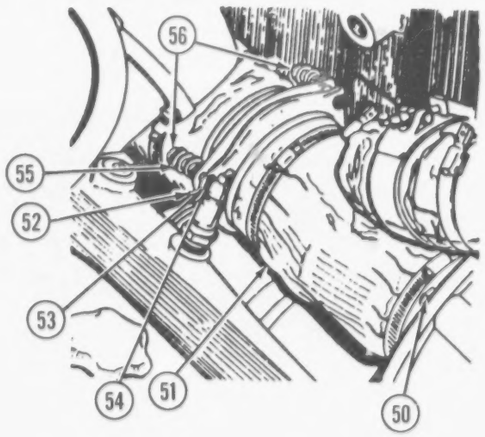
26 Remove screw (45) and washer (46) from rubber coated clamp (47).

TA472133

POWERPLANT - CONTINUED



27 Remove fixed fire extinguisher nozzle (48) by unscrewing swivel nut (49).

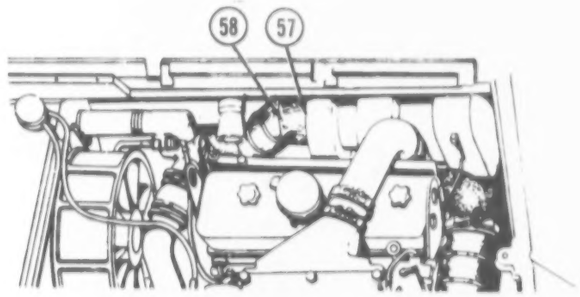


NOTE

If you cannot rotate the triangular shaped flange for easy removal and replacement of spring bolt, due to bulkhead interference, remove four bolts (50) from mounting flange, pull exhaust pipe (51) away from bulkhead, and remove spring bolt. After separation of exhaust duct at triangular flange, install four bolts (50) in mounting flange.

28 Remove engine exhaust pipe flanges (52) by removing three cotter pins (53), three castle nuts (54), three springs (55), and three screws (56). Discard cotter pins.

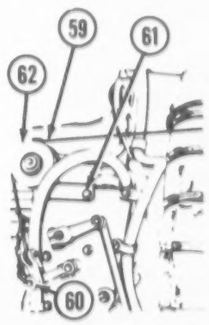
TA472134



29 Loosen clamp (57).

30 Remove engine exhaust pipe (58) and place on top of engine.

TOP LEFT-ENGINE



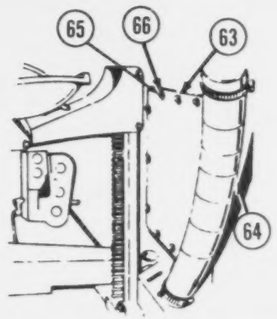
31 Remove governor fuel shutoff cable (59). First pull out quick release pin (60) then remove two screws (61) from pulley (62). Lay cable (59) on hull.

TA472135

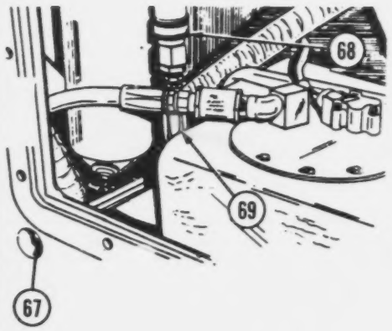
POWERPLANT - CONTINUED

a. Removal - Continued

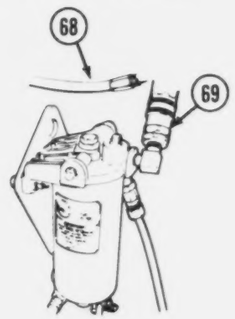
DRIVER'S COMPARTMENT



32 Remove engine compartment access door (63) by disconnecting and pulling the hose (64) away from the access door (63) then by removing 12 screws (65) and 12 lockwashers (66).



TOP RIGHT-ENGINE



NOTE

Position of primary fuel filter differs in the M109A2 and M109A3 (ref. p. 6-14).

33 Loosen engine mount release shaft (67) by turning counterclockwise.

34 Disconnect quick disconnect (68) of primary fuel filter input hose (69).

TA472136

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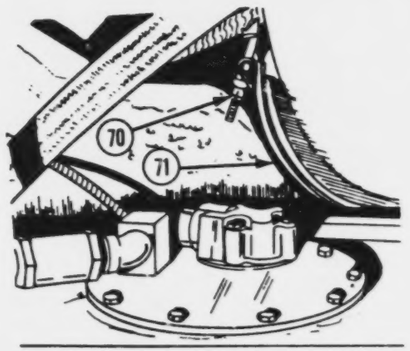
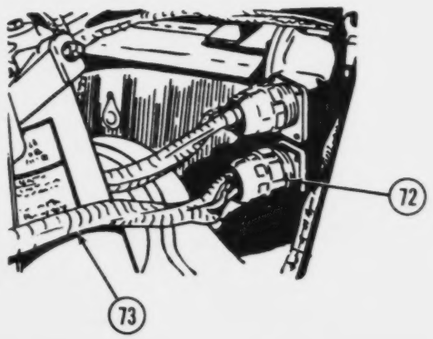


REAR POWERPLANT COMPARTMENT

35 Loosen nut (70) to remove clamp (71) of the air cleaner duct.



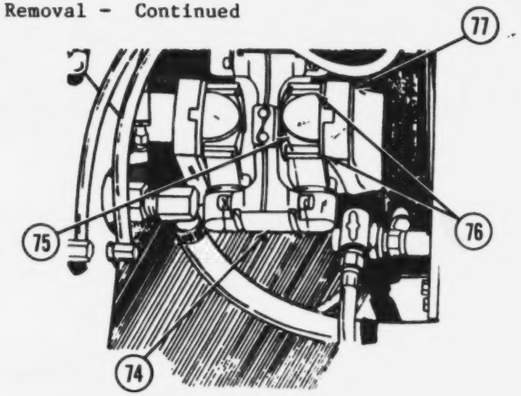
FRONT POWERPLANT COMPARTMENT

36 Disconnect electrical connector (72) of the alternator-to-rectifier harness (73).

TA472137

POWERPLANT - CONTINUED

a. Removal - Continued

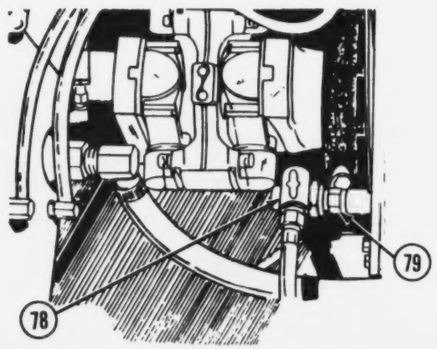


NOTE

- Turn universal joint on left side of vehicle straight up and down.
- If adapter screws are inaccessible, remove blocking from vehicle tracks and push or tow vehicle until universal joints rotate sufficiently to gain access to adapter screws.

37 Remove the right universal joint (74) by removing the safety wire (75) and four screws (76). Push apart universal joint from flange (77) on transmission. Repeat this procedure for the left final drive universal joint (74). Discard safety wires (75) upon removal.

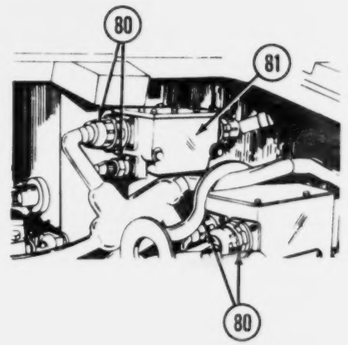
TRANSMISSION-
RIGHT FRONT



38 Remove speedometer right angle drive (78) by unscrewing nut (79).

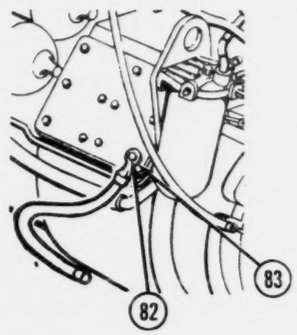
TA472138

POWERPLANT COMPARTMENT
LEFT



39 Disconnect four electrical connectors (80) of the master relay (81) and regulator.

HULL-
FRONT BULKHEAD



NOTE

Step 40 applies only to M109A2/M109A3 vehicles.

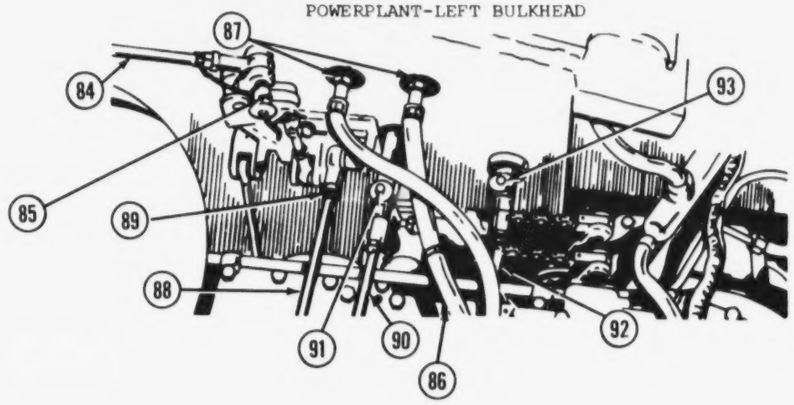
40 Remove the powerplant ground cable removing the screw (82) and lockwasher (83) from the powerplant.

TA472139

POWERPLANT - CONTINUED

a. Removal - Continued

POWERPLANT-LEFT BULKHEAD



CAUTION

After disconnecting, insure steer and shift control rods are in the driver's compartment wall to prevent damage when the powerplant is hoisted or reinstalled.

41 Release throttle governor control rod (84) by moving throttle control to full open position and pulling out quick release pin (85).

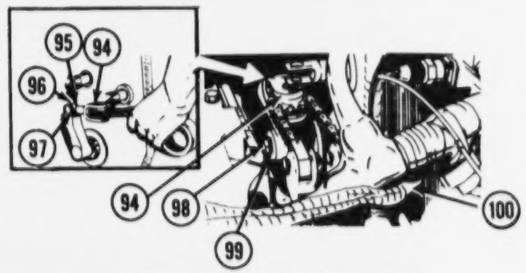
42 Remove tachometer and speedometer flexible drive shafts (86) by unscrewing two nuts (87). Tag cables before removal to avoid wrong connections during installation.

43 Disconnect throttle valve control rod (88) by unscrewing nut (89).

44 Disconnect steer control rod (90) by pulling out quick release pin (91). Move control rod into hull to prevent damage.

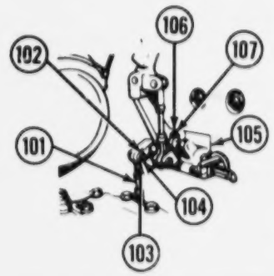
45 Disconnect shift control rod (92) by pulling out quick release pin (93). Move control rod into hull to prevent damage. Place shift control in R position.

TA472140



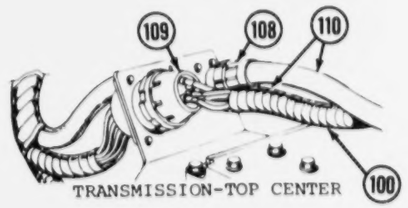
POWERPLANT-LEFT BULKHEAD

46 Disconnect brake control sprocket and shaft (94) by removing cotter pin (95), retainer pin (96) and washer (97). Discard cotter pin (95). Release brake arm by removing screw (98) and washer (99). Cut tape (100) if used to bind alternator-to-rectifier cable to starter cable.



47 Disconnect throttle control tube (101) by removing cotter pin (102), retainer pin (103) and washer (104). Discard cotter pin (102).

48 Remove accelerator and throttle control bracket (105) by removing three screws (106) and three lockwashers (107).



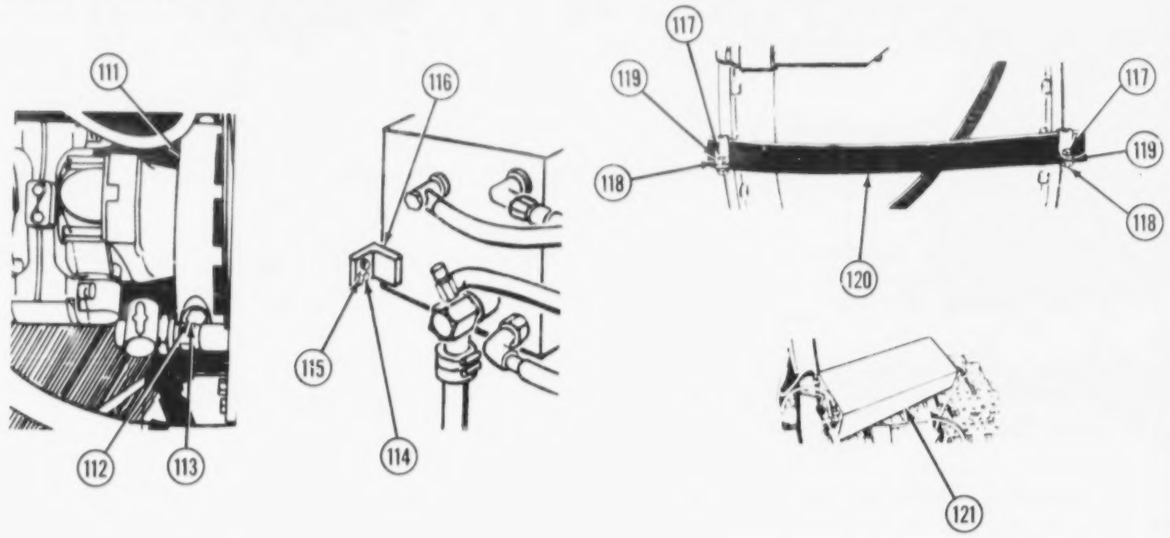
TRANSMISSION-TOP CENTER

49 Disconnect starter cable connector (108) and master circuit harness connector (109). Cut tape if used to bind alternator-to-rectifier cable to starter cable (110).

TA472141

POWERPLANT - CONTINUED

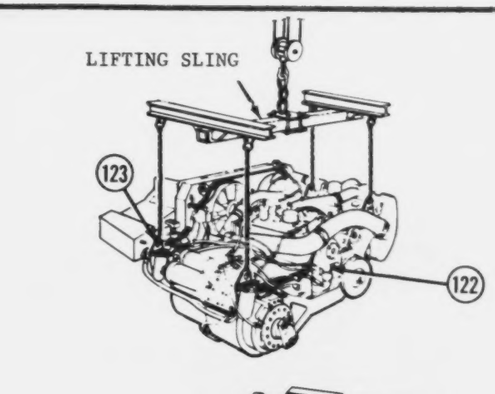
a. Removal - Continued

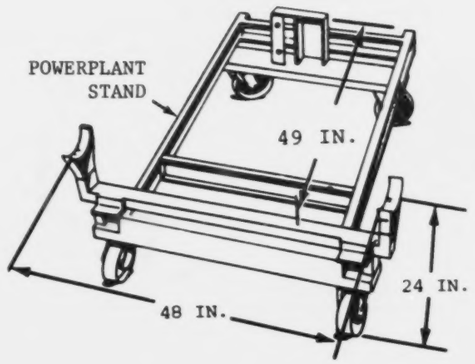


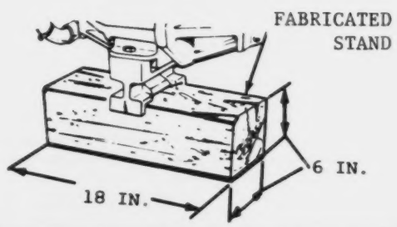
50 Remove left tranmission support cap (111) from support assembly by removing two screws (112) and two lockwashers (113). Repeat for right support assembly.

51 Remove two screws (114), two lockwashers (115) and retainer pad (116). Remove two screws (117), two nuts (118) and two lockwashers (119) on the coolant pump to surge tank hose (120). Remove coolant surge tank (121) and place on top of transmission.

TA472142







WARNING

Perform visual inspection and check load test date on lifting sling. Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise extreme caution when working near a cable or chain under tension.

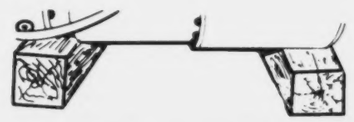
CAUTION

Use extreme care when removing/installing the powerplant to avoid damaging the fuel tanks and radiator.

52 To lift powerplant from hull, attach lifting sling (Item 32, App. B) to powerplant (122) at four lifting eyes (123).

53 Lift powerplant (122) out of hull slowly. After lifting powerplant several inches, shift it towards front of vehicle for clearance. Watch all sides of powerplant to insure clearance during removal.

54 Place powerplant on stand or fabricated stand.



TRANSMISSION BLOCKING

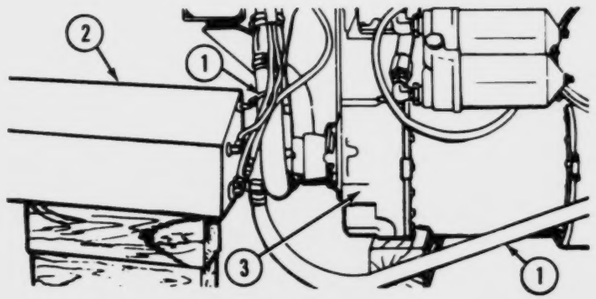
TA472143

POWERPLANT - CONTINUED

b. Inspection

Operating the powerplant out of the vehicle lets maintenance personnel inspect the control and drive components of the powerplant unit by hand-operating the control linkages on the transmission. Components can be checked for proper functioning and performance with the powerplant unit outside the vehicle without harm to the unit.

c. Special equipment hook-up



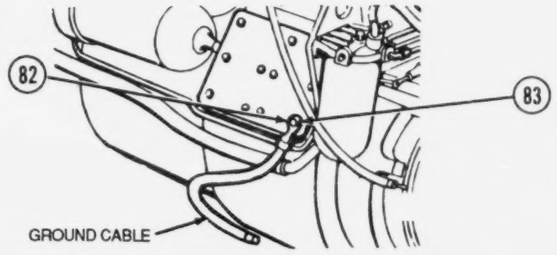
CAUTION

Insure all hoses are connected and secure.

1 Check hoses and connectors (1) of surge tank (2) connections. Insure hoses are not kinked.

2 Position surge tank (2) next to powerplant transmission left side at final drive universal joints (3).

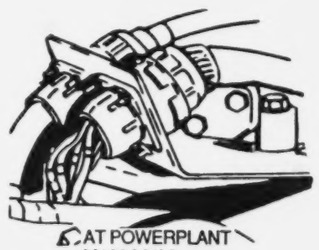
TA472144

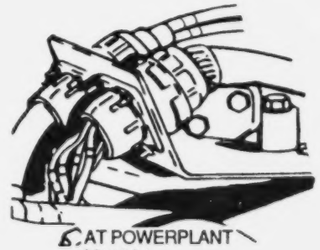


NOTE

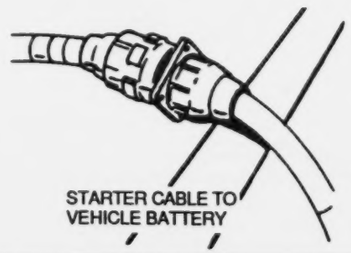
Step 3 applies only to M109A2/M109A3 vehicles.

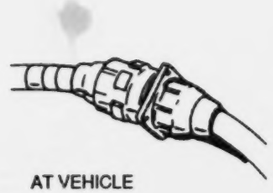
3 Connect ground cable (Item 26, App. B) to powerplant and vehicle with washer (83) and screw (82). Be certain paint is off vehicle at connection point.





4 Connect engine starter cable connector and master circuit power harness connector (Item 28, App. B). On M109A4's also connect starter circuit cable assembly (Item 26.1, App. B).

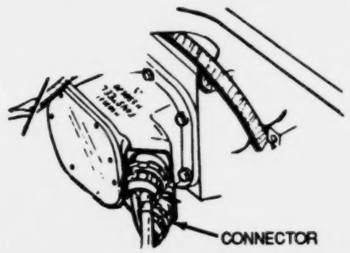




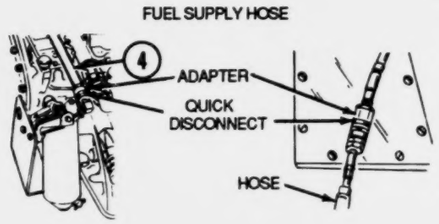
TA472145

POWERPLANT - CONTINUED

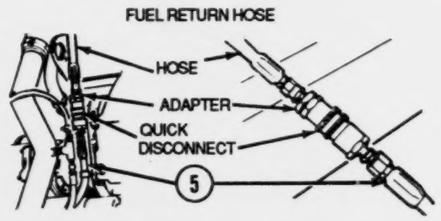
c. Special equipment hook-ups - Continued



5 Connect rectifier to alternator harness connector (Item 27 (M109A2/M109A3), Item 27.1 (M109A4) App. B).

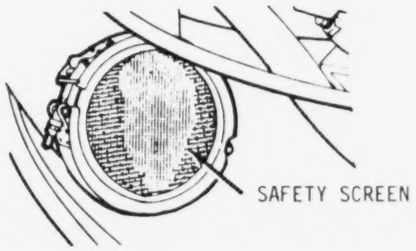


6 Install adapter (Item 24, App. B) quick-disconnect (Item 29, App. B), hose (Item 30, App. B) and fuel supply hose assembly (4).

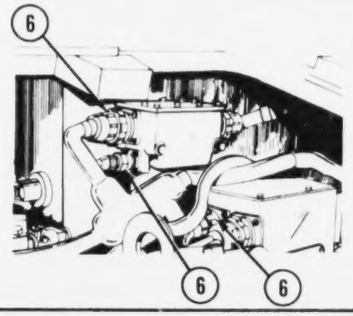


7 Install fuel return hose assembly (5), adapter (Item 24, App. B), quick-disconnect (Item 29, App. B) and hose (Item 30, App. B).

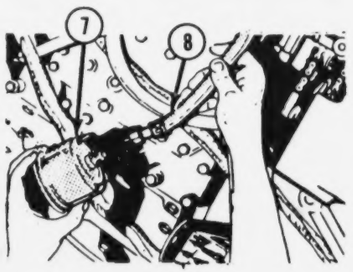
TA472146



8 Install air inlet safety screen (Item 31, App. B).



9 Connect three wiring harnesses (6) at master relay and regulator.



10 Attach tachometer (7) to tachometer flexible drive shaft assembly (8) and position it where it will not be affected by engine vibration.

TA472147

POWERPLANT - CONTINUED

d. Test run

WARNING

The rotation of the radiator cooling fans create a hazard during maintenance on a running engine. Exercise care to prevent injury, especially to fingers and hands, during maintenance operations on a running engine. Excessive noise levels are present any time the equipment is operating. Wear hearing protection while it is running. Failure to do so could result in damage to your hearing.

CAUTION

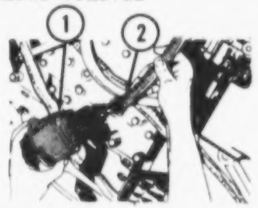
- Ensure coolant and engine lubricants are replenished before starting engine.
- When operating the powerplant while mounted on blocks, watch closely. Prevent powerplant from vibrating off the blocks.
- While performing stall test run, check coolant and oil temperatures. Coolant temperature should not exceed 180°F (82°C). Oil temperature should not exceed 259°F (121°C). If either condition exists, run engine at 1000-1200 rpm for 2 minutes before shutdown.

1 Start engine and operate at 1200 to 1400 rpm until engine coolant temperature is 169°F (76°C) and transmission oil temperature is 160°F (71°C). Allow engine to return to normal idle speed (650 rpm).

2 Check engine operation.

3 Check for leaks, excess smoke or strange noises. Try to locate the source of leaks. If any problems persist, notify Support Maintenance.

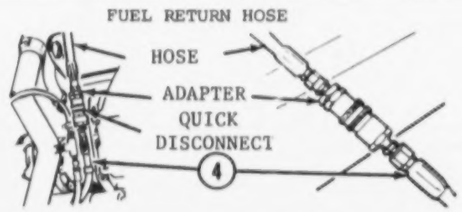
e. Special equipment removal



1 Remove tachometer (1) from tachometer flexible drive shaft assembly (2).

2 Remove three wiring harnesses (3) at master relay and regulator.

3 Remove air inlet safety screen.



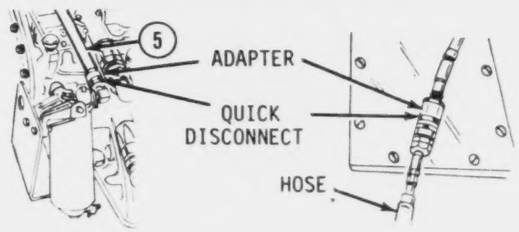
4 Remove fuel return hose assembly (4), adapter, quick-disconnect and hose.

TA472148

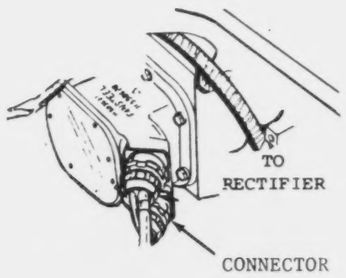
POWERPLANT - CONTINUED

e. Special equipment removal - Continued

FUEL SUPPLY HOSE

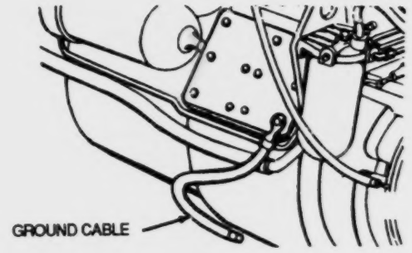


5 Remove adapter, quick-disconnect, hose and fuel supply hose assembly (5).



6 Disconnect rectifier to alternator harness connector, engine starter cable connector and master circuit power harness connector.

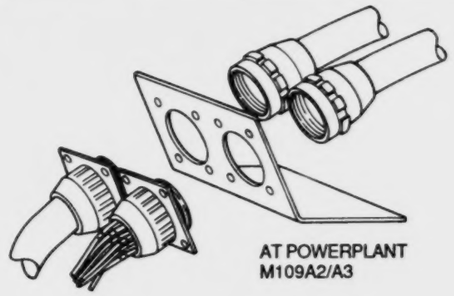
TA472149



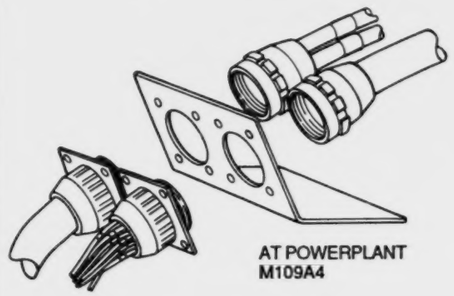
NOTE

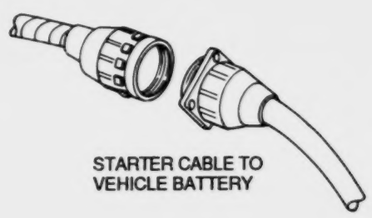
Step 7 applies only to M109A2/M109A3 vehicles.

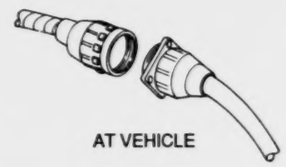
7 Disconnect ground cable from vehicle.



8 Check to be certain all connections, connectors and hoses are properly positioned for easy installation of the powerplant.



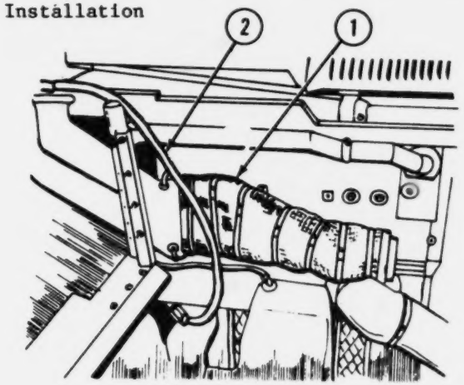




TA472150

POWERPLANT - CONTINUED

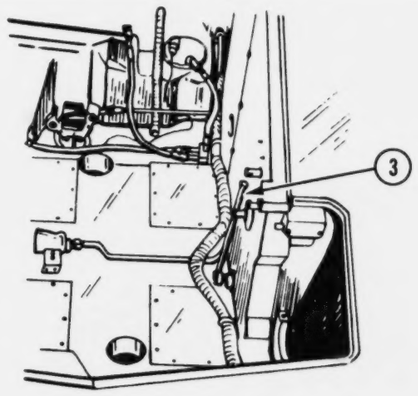
d. Installation



NOTE

Be sure to lubricate and exercise engine mounting bracket before installing powerplant (ref. LO 9-2350-311-12).

1 Position engine exhaust pipe (1) and fuel return hose (2) against powerplant compartment wall.

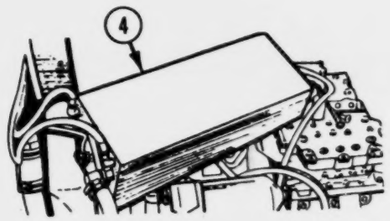


CAUTION

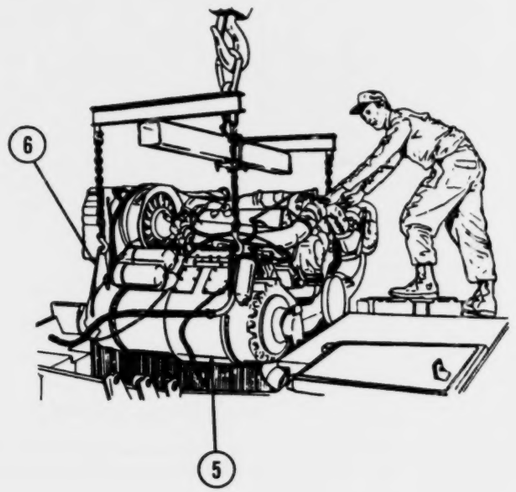
Failure to secure accelerator/ throttle linkage to engine compartment wall may damage linkage.

2 Fasten throttle valve control rod linkage (3) to compartment wall.

TA472151



3 Place surge tank (4) on top of powerplant.



4 Position lift vehicle for powerplant (5) installation.

5 Attach lifting sling (Item 32, App. B) to powerplant at lifting eyes (6).

CAUTION

Watch all sides of the powerplant, making sure it clears the hull. Have one man observe from the driver's compartment through the engine compartment access to ensure air intake duct isn't forced into fuel tank, damaging it.

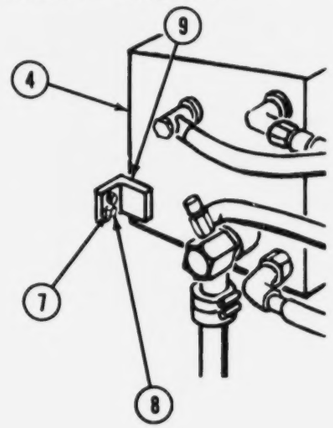
6 Lift and set powerplant in vehicle hull.

7 Remove lifting sling from powerplant.

TA472152

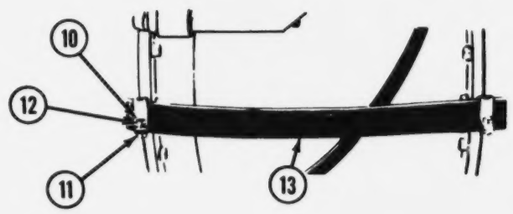
POWERPLANT - CONTINUED

d. Installation - Continued



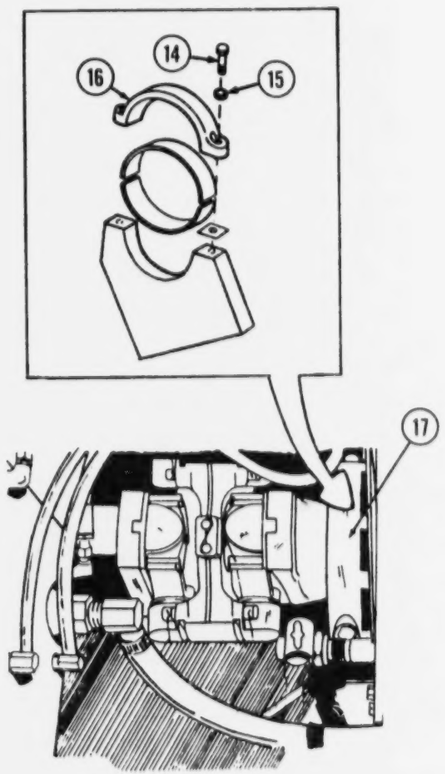
8 Install two screws (7), two lockwashers (8) and retainer pad (9) to install surge tank (4).

TRANSMISSION-FRONT



9 Install two screws (10), two nuts (11) and two lockwashers (12) on coolant pump to surge tank hose (13).

TA472153



NOTE

- Ensure trunnion cap shims are installed at the original location from which they are removed.
- Ensure trunnion caps are installed in proper location as marked on caps (left front and right front) with stamp facing towards front of vehicle.
- Primary fuel pump bracket (lifting eye) must be disconnected and removed to install and properly torque right front trunnion cap screws.

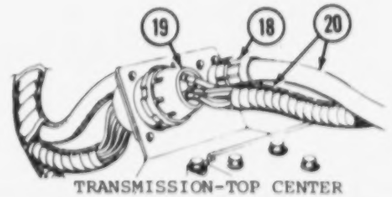
10 Install two screws (14), two lockwashers (15) and support cap (16) at right support assembly (17). Torque screws (14) to 85-90 lb-ft.

11 Repeat Step 10 for left support assembly.

TA472154

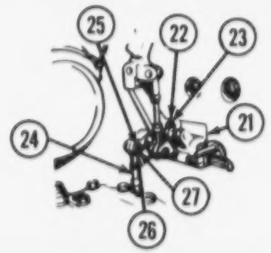
POWERPLANT - CONTINUED

d. Installation - Continued



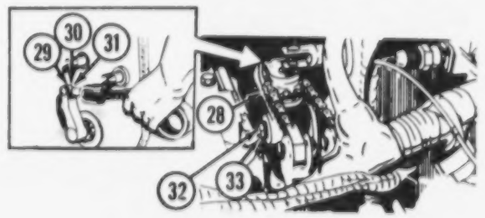
TRANSMISSION-TOP CENTER

12 Connect starter cable connector (18) and master circuit harness connector (19) of engine starter cable and master circuit harness (20).



13 Install accelerator and throttle control bracket (21) with three screws (22) and three lockwashers (23).

14 Connect throttle control tube (24) by inserting the retaining pin (25) cotter pin (26) with washer (27).

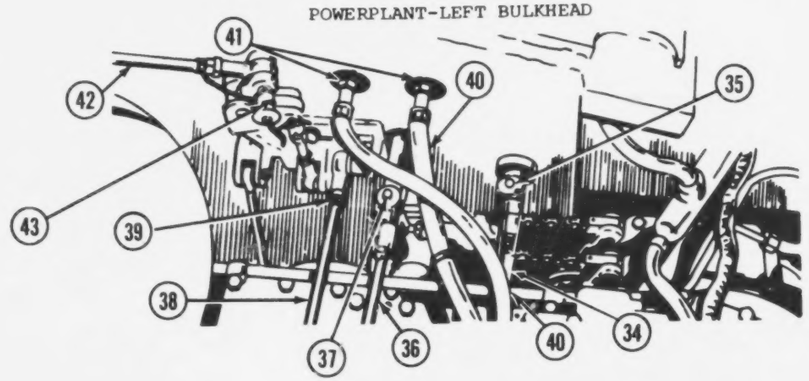


15 Connect brake control sprocket and shaft (28) by installing cotter pin (29), retainer pin (30) and washers (31). Secure brake arm by installing screw (32) and washer (33).

POWERPLANT-LEFT BULKHEAD

TA472155

POWERPLANT-LEFT BULKHEAD



16 Place shift control in R2 position. Connect shift control (34) by installing quick-release pin (35).

17 Place steering wheel to right position. Connect steer control rod (36) by installing quick-release pin (37).

18 Move throttle control to full open position. Connect throttle valve control rod (38) by tightening nut (39).

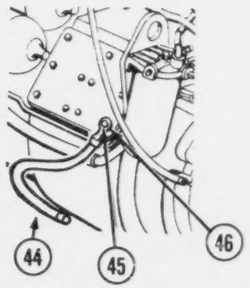
19 Connect tachometer and speedometer flexible drive shafts (40) by tightening two nuts (41).

20 Connect throttle governor control rod (42) by installing quick-release pin (43).

TA472156

POWERPLANT - CONTINUED

d. Installation - Continued

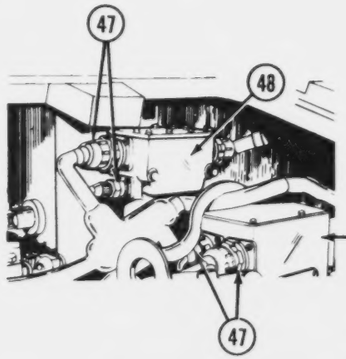


HULL-
FRONT BULKHEAD

NOTE

Step 22 applies only to M109A2/M109A3 vehicles.

22 Connect powerplant ground cable (44) by installing screw (45) and lockwasher (46).

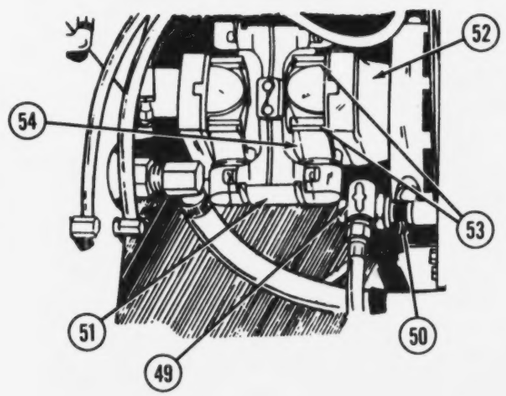


POWERPLANT COMPARTMENT
LEFT

23 Connect four electrical connectors (47) of the master relay (48) and regulator.

TA472157

TRANSMISSION-
RIGHT FRONT



24 Install speedometer right angle drive (49) by tightening nut (50).

25 Install right universal joint (51) by positioning flange (52) against the universal joint (51) and installing four screws (53). Place safety wire (54) through the four screws to prevent screws from turning. Repeat this procedure for the left final drive universal joint.

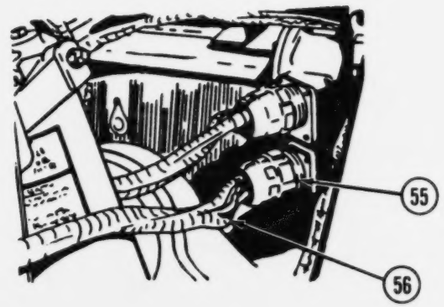
NOTE

- Turn universal joint on left side of vehicle straight up and down.
- If adapter screws (53) are inaccessible, remove blocking from vehicle tracks and push or tow vehicle until universal joints rotate enough to gain access to adapter screws (53).

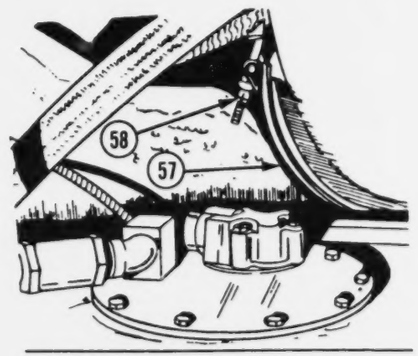
TA472158

POWERPLANT - CONTINUED

d. Installation - Continued



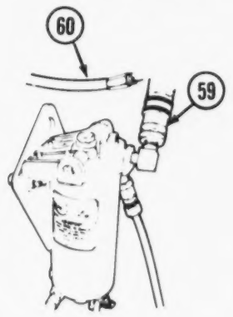
26 Connect electrical connector (55) of the generator to rectifier harness (56).



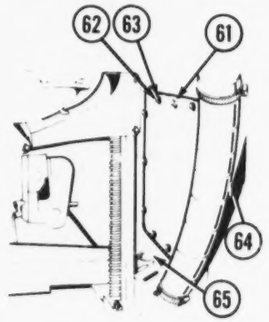
27 With access through driver's compartment access cover, set clamp (57) and tightening nut (58).

TA472159

TOP RIGHT-ENGINE



DRIVER'S COMPARTMENT



NOTE

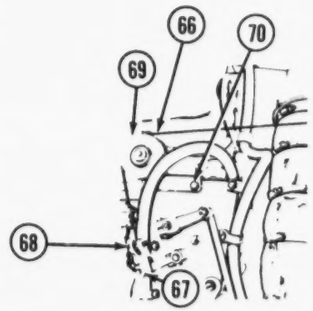
Positions of primary fuel filters differ in the M109A2 and M109A3 (ref. p. 6-14).

28 Connect quick disconnect (59) of primary fuel filter input hose (60).

29 Install engine compartment access cover (61) by installing 12 screws (62) and 12 lockwashers (63). Connect hose (64).

30 Tighten engine mount release shaft (65) by turning clockwise. Torque shaft to 174 lb-ft (235 Nm).

TOP LEFT-ENGINE

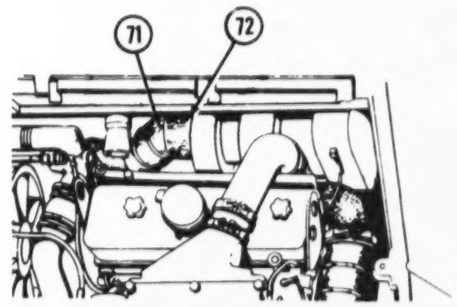


31 Install governor fuel shutoff cable (66) by placing quick-release pin (67) through clevis (68). Install pulley (69) with two screws (70).

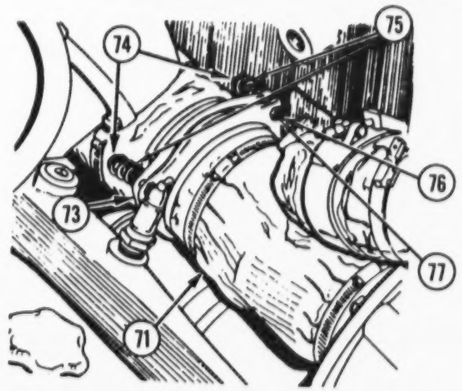
TA472160

POWERPLANT - CONTINUED

d. Installation - Continued

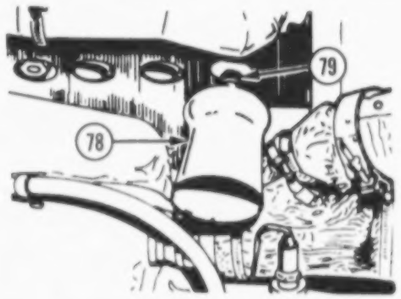


32 Install engine exhaust pipe (71) and tighten clamp (72).



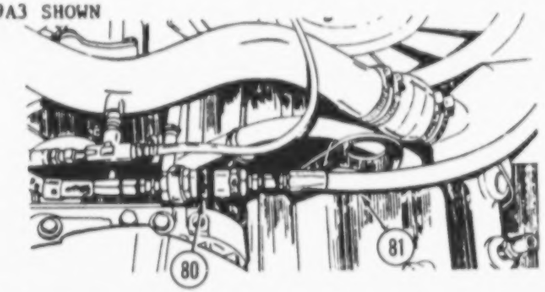
33 Install engine exhaust flanges (73) by three screws (74), three springs (75), three castle nuts (76) and three cotter pins (77).

TA472161



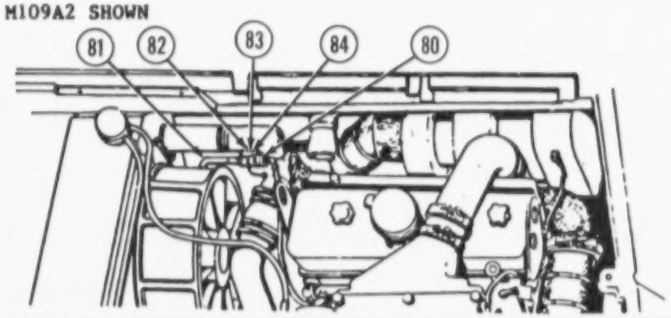
34 Install fixed fire extinguisher nozzle (78) by tightening swivel nut (79).

M109A3 SHOWN



35 Connect quick disconnect assembly (80) of engine to lower fuel tank return hose (81). Install screw (82) and washer (83) at clamp (84).

M109A2 SHOWN



TA472162

POWERPLANT - CONTINUED

d. Installation - Continued

WARNING

The rotation of the radiator cooling fans create a hazard during maintenance on a running engine. Exercise care to prevent injury, especially to fingers and hands, during maintenance operations on a running engine. Excessive noise levels are present any time the equipment is operating. Wear hearing protection while it is running. Failure to do so could result in damage to your hearing.

CAUTION

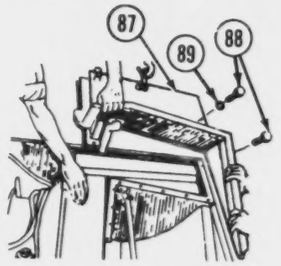
- Ensure coolant and engine lubricant are replenished before starting engine.
- While performing test run, check coolant and oil temperatures. Coolant temperature should not exceed 180°F (82°C). Oil temperature should not exceed 259°F (121°C). If either condition exists, run engine at 1000-1200 rpm for 2 minutes before shutdown.

36 Connect both battery ground straps (ref. p. 8-56). Place MASTER switch in ON position. Start engine and operate at 1200 to 1400 rpm until engine coolant temperature is 169°F (76°C) and transmission oil temperature is 160°F (71°C). Allow engine to return to normal idle speed (650 rpm).

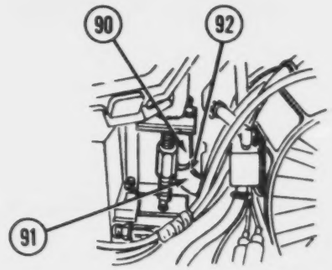
37 Check engine operation. If engine is not operating properly perform STE/ICE PMCS testing (ref. p. D-1).

38 Check for leaks, excess smoke or strange noises. Try to locate the source of leaks. If any problems persist, notify Support Maintenance.

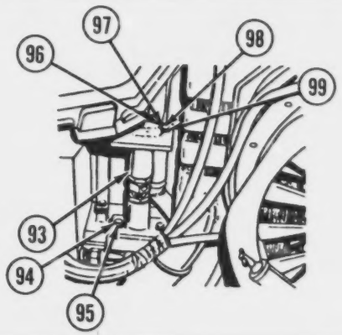
39 Install air intake grille handle bracket (85) with two screws (86).



40 Install right front grille assembly (87) using six socket-head screws and seven screws (88) and seven washers (89).



41 Attach bilge pump hose (90) to connector tube (91). Tighten hose clamp (92).

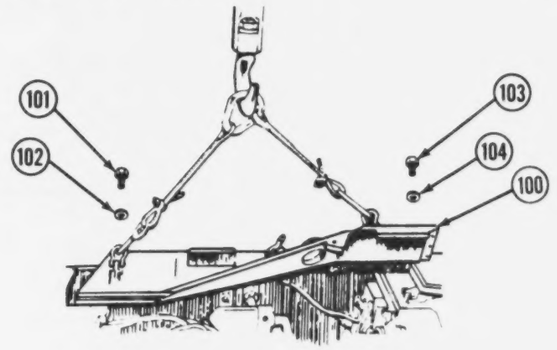


42 Install grille support assembly (93) with two screws (94), two washers (95), two screws (96), four washers (97), two lockwashers (98), and two nuts (99).

TA472163

POWERPLANT - CONTINUED

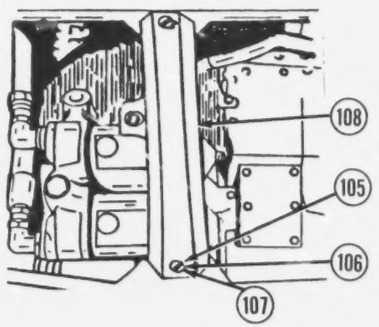
d. Installation - Continued



WARNING

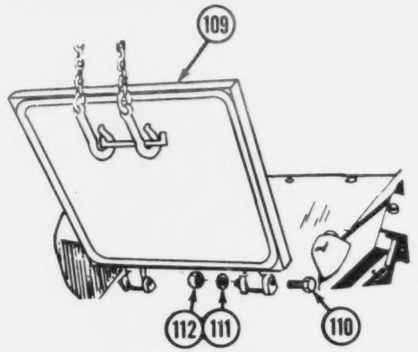
Center front slope plate assembly is heavy. Do not allow front slope plate to swing while suspended by hoist and sling. Use caution when working near a sling under tension to prevent severe injury.

43 Install center front slope plate assembly (100) using seven screws (101), seven washers (102), three screws (103) and three washers (104).

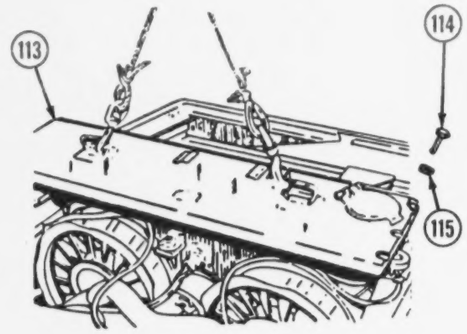


44 Install lower screw (105), flatwasher (106), and hex nut (107) from transmission door support (108). Close transmission access doors.

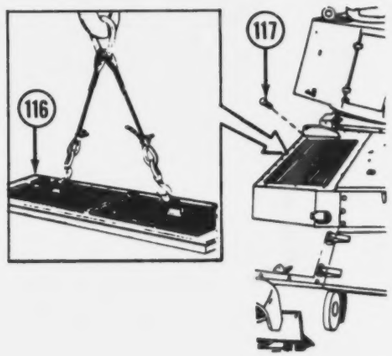
TA472164



45 Install right transmission access door (109) using two screws (110), two washers (111), and two self-locking nuts (112). Repeat procedure for left transmission access door.



46 Install radiator fan access door (113) using six screws (114) and six washers (115).

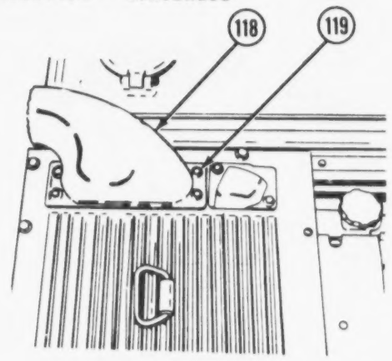


47 Install engine exhaust grille (116) using 14 screws (117).

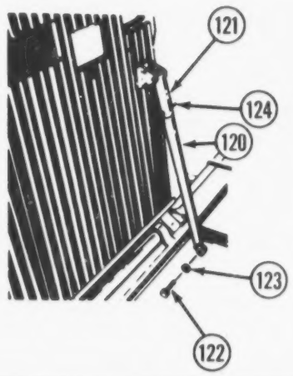
TA472165

POWERPLANT - CONTINUED

d. Installation - Continued

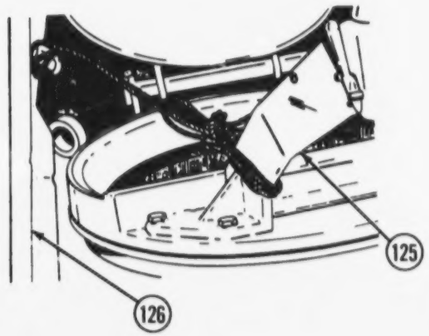


48 Install packing in exhaust deflector seat. Install exhaust deflector (118) using four screws (119).

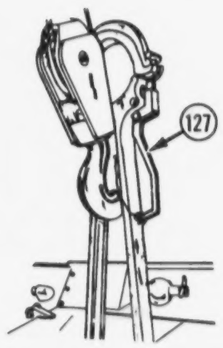


49 Install air intake grille hold-open support arm (120) by inserting arm in upper sleeve (121) and installing screw (122) and flatwasher (123). Insert support arm pin (124) to hold open air intake grille.

TA472166



50 Remove rope/strap secured to machine-gun pintle mount (125) and lower air intake grille (126).

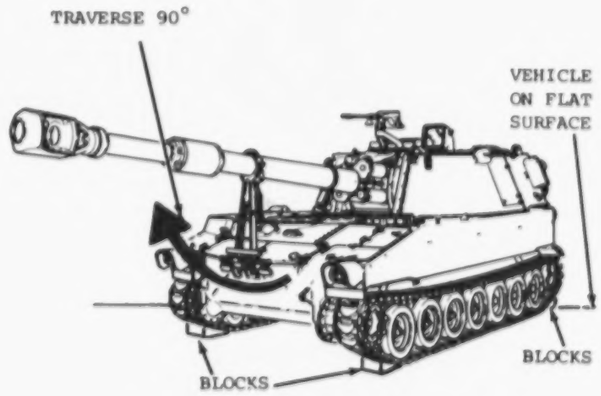


51 Install travel lock (127) (ref. p. 11-32).

TA472167

POWERPLANT - CONTINUED

d. Installation - Continued



52 Open travel lock and traverse the gun tube so it is centered to the travel lock. Lock travel lock around gun tube.

53 Set parking brake and remove blocks from under tracks.

54 Release parking brake and operate vehicle.

TA472168

CHAPTER 5
ENGINE COMPONENTS

GENERAL

This chapter illustrates and describes maintenance functions and procedures for various engine components, including instructions for removal, disassembly, assembly, installation and inspection.

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5-4	OIL FILTER	5-8
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5-6	ENGINE MOUNT BASE ASSEMBLY	5-12
5-7	SHOCK MOUNT AND BRACKET	5-14
5-8	FUEL SHUT-OFF ASSEMBLY	5-16
5-9	TURBOCHARGER REGULATOR	5-18

ENGINE COMPONENTS

5-1. LUBRICATION

Engine lubrication requirements and procedures are defined in LO 9-2350-311-12.

5-2. ENGINE INSPECTION

This task covers:

Inspection

Inspection

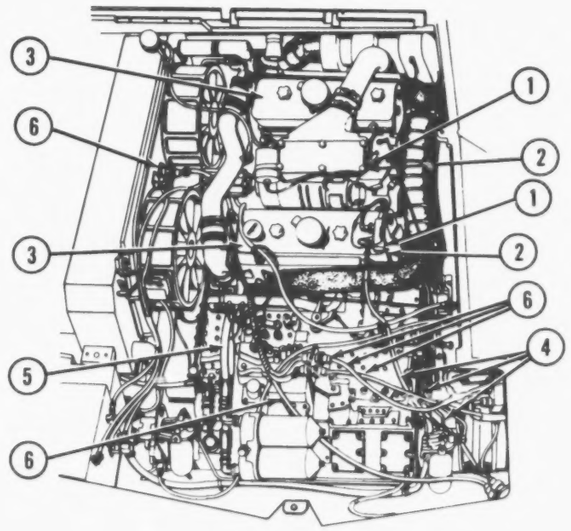
NOTE

Prior to inspection, make sure:

- Air intake grille is open
- Transmission access doors are open
- Engine compartment access cover is removed

1 Check gaskets (1), seals (2), and covers (3) for seepage of fuel and oil.

2 Check for damaged, distorted, or broken hose, tube or line connector (4) assemblies (nuts, adapters, reduction fittings and couplers).



3 Check fuel hoses, tubes and connectors (4) for cracks, leaks and/or seepage of fuel (ref. p. 6-24).

4 Check oil hoses, tubes and connectors (5) for cracks, leaks and/or seepage of oil (ref. p. 5-6 and 9-7).

5 Check for stripped or damaged threads on connector (6) assemblies and/or retaining bolts, nuts or studs. Repair threads or replace components/item as appropriate.

6 Check electrical wires, leads and connectors (6) for cracked insulation, oil and grease on cables/connectors (ref. p. 8-68).

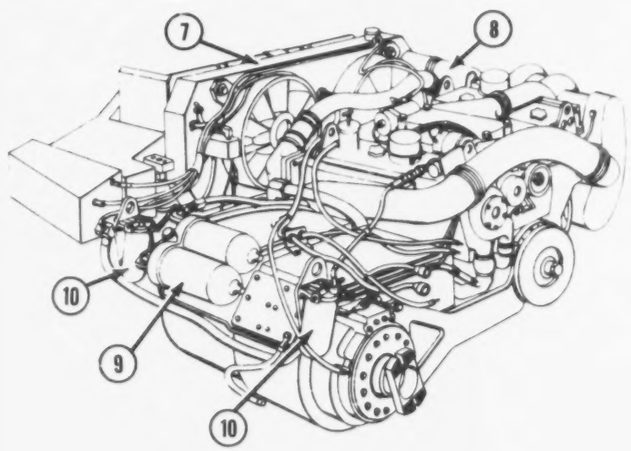
7 Check for broken screws or bolts. If broken, drill and remove with "Easy-Out". Replace broken screw or bolt.

TA472169

ENGINE COMPONENTS - CONTINUED

5-2. ENGINE INSPECTION - CONTINUED

a. Inspection - Continued



8 Check for damaged, burred, pitted or gummed-up seal, gasket or preformed packing seats. Clean, remove burrs, or replace components as required. If damaged beyond repair or if scope of the task is beyond Organizational Maintenance capability, notify support maintenance.

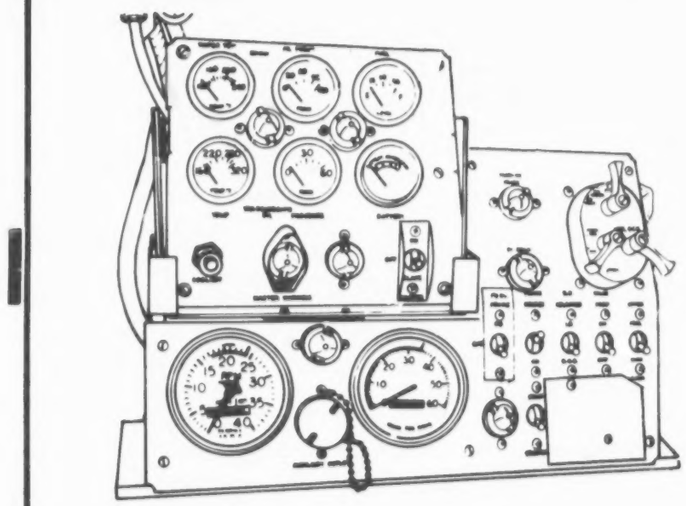
9 Check hull engine compartment floor for pools of oil/fuel and coolant.

WARNING

Be sure engine is cool before removing radiator cap. Hot coolant can cause severe burns.

10 Check radiator (7) for coolant level and specific gravity (ref. p. 2-46).

TA472170



11 Check coolant hoses (8) for cracks, deterioration and signs of coolant seepage (ref. p. 7-2 through 7-7).

12 Check oil filters (9) and fuel filters (10) for collection of sediment on filter elements (ref. p. 5-8 and 6-14).

13 Start-up engine and check instrument panel indicators (ref. TM 9-2530-311-10).

TA472171

ENGINE COMPONENTS - CONTINUED

5-3. OIL COOLER HOSES

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Preformed packing (as required)
Straps

Tools
Automotive Maintenance
Common No. 2 Tool Kit
SC 4910-95-CL-A72

a. Removal

WARNING

Be sure exhaust is cool before removing hoses to prevent burns or injury.

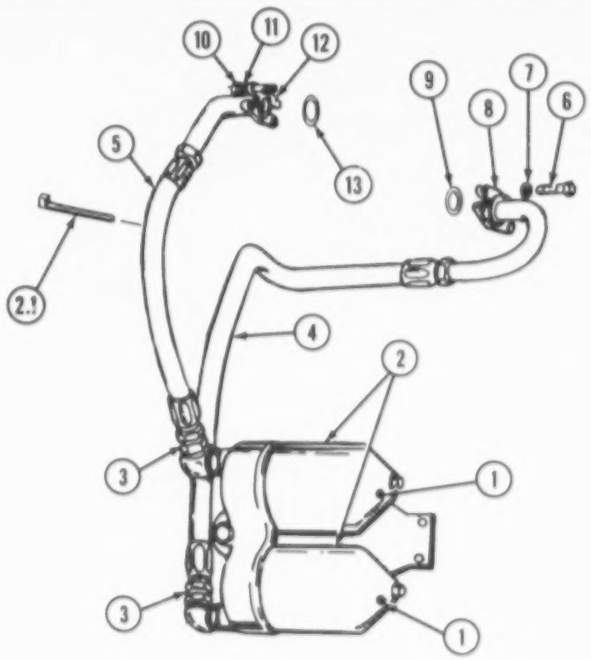
1 Remove two drain plugs (1) from oil filters (2), draining oil from filters.

1.1 Remove strap (2.1) from hoses (M109A4 only).

2 Remove two nuts (3) to disconnect hoses (4) and (5).

3 Remove four screws (6) and four lockwashers (7).

4 Remove split flange (8), preformed packing (9) and hose (4) from front of engine oil cooler. Discard preformed packing.



5 Remove four screws (10) and four lockwashers (11).

6 Remove split flange (12), preformed packing (13) and hose (5) from rear of engine oil cooler. Discard preformed packing (13).

b. Installation

1 To install oil cooler hoses, reverse order of removal.

2 Check engine oil level (ref. LO 9-2350-311-12).

3 Replace preformed packings (9) and (13).

TA472172

ENGINE COMPONENTS - CONTINUED

5-4. OIL FILTER ASSEMBLY

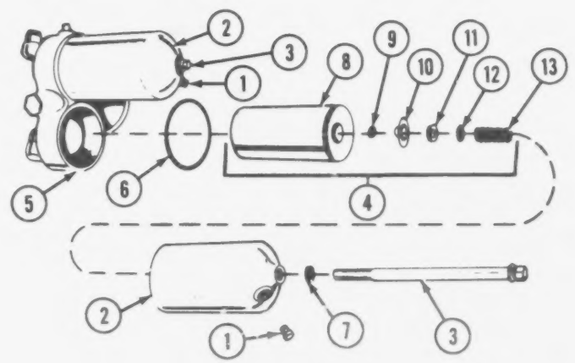
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts	Tools
Gaskets (6)	Automotive Maintenance
Filter elements	Common No. 2 Tool Kit
	SC 4910-95-CL-A72

a. Removal



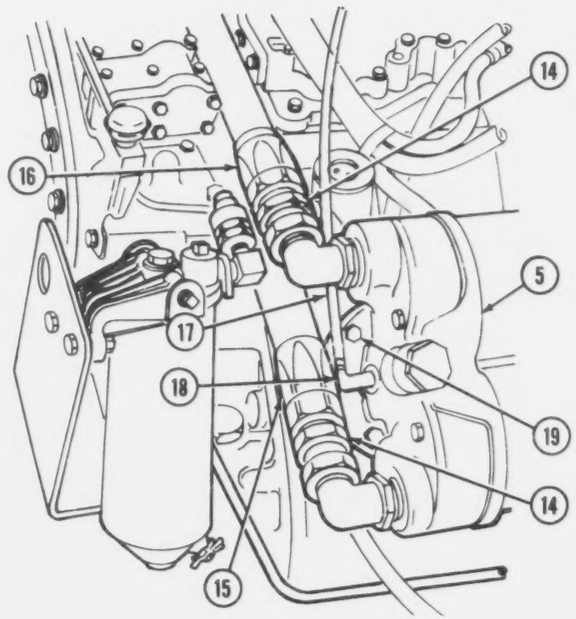
1 Open transmission access doors (ref. p. 4-10).

2 Remove two drain plugs (1) and drain oil from filter sheels (2). Use container to catch draining oil.

3 Unscrew two center studs (3).

4 Remove two filter elements (4), two filter shells (2), and gasket (6) from adapter (5). Discard gasket.

TA472173



5 Remove from shell (2) two of each of the following: center stud (3), gasket (7), filter element (8), retaining ring (9), retainer (10), gasket (11), washer (12) and spring (13).

6 Unscrew two nuts (14) and disconnect hoses (15) and (16).

7 Disconnect oil sampling hose (17) at elbow and then remove elbow (18).

8 Remove four screws (19) and adapter (5).

NOTE

Illustration shown is the M109A2 vehicle. The procedure is identical with the M109A3 vehicle.

b. Installation

1 To install oil filter assembly, reverse order of removal.

2 Replace two gaskets (6), two gaskets (7), and two gaskets (11).

3 Torque stud (3) to 40-50 lb-ft (54.2 to 67.8 Nm).

4 Check oil level (ref. TM 9-2350-311-10).

TA472174

ENGINE COMPONENTS - CONTINUED

5-5. CRANKCASE AND GEAR TRAIN BREATHER TUBES

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Gaskets

a. Removal

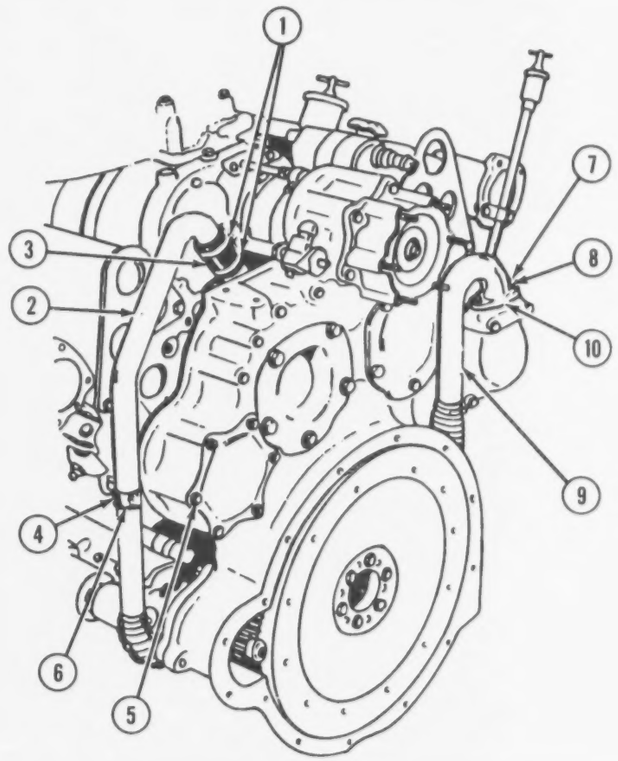
1 Remove powerplant from vehicle (ref. p. 4-1).

2 Loosen two clamps (1) by unscrewing screws to remove crankcase breather tube (2).

3 Pull crankcase breather tube (2) out of hose (3).

4 To remove gear train breather tube, remove nut (4), screw (5) and retaining clamp (6).

5 Remove two screws (7) and two washers (8).



6 Pull off gear train breather tube (9).

7 Remove gasket (10) and discard.

b. Installation

1 To install crankcase and gear train breather tubes, reverse order of removal.

2 Install new gasket (10).

TA472175

ENGINE COMPONENTS - CONTINUED

5-6. ENGINE MOUNT BASE ASSEMBLY

This task covers:

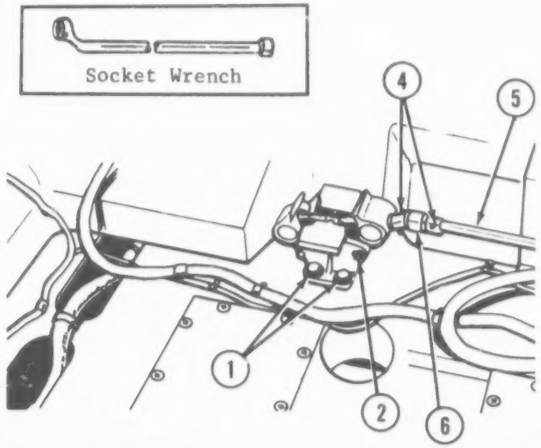
a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Special Tools
Socket wrench (Item 34, App. B)

Materials/Parts
6 cotter pins

a. Removal

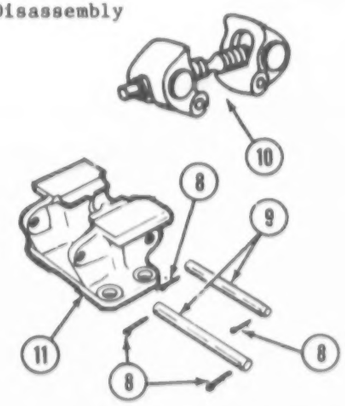


1 Remove powerplant (ref. p. 4-1).

2 Remove four screws (1) and mount base assembly (2), using socket wrench (Item 34, App. B).

TA472176

b. Disassembly



1 Remove two cotter pins (4) and discard them.

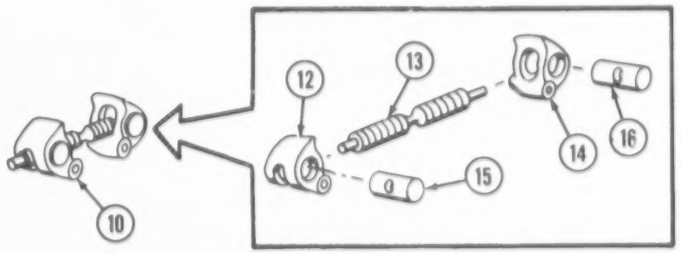
2 Separate mount handle (5) and universal joint (6), and remove from mount base (2).

3 Remove four cotter pins (8) and two jaw pins (9). Discard four cotter pins.

4 Remove jaw assembly (10) from mount (11).

5 Turn jaw (12) counterclockwise to remove from bolt (13).

6 Inspect mount base (11), two jaws (12) and (14), and jaw nuts (15) and (16) for cracks.



7 Turn jaw (14) clockwise to remove from bolt.

8 Slide jaw nuts (15) and (16) out of jaws (14) and (15).

9 Inspect bolt (13) and jaw nuts (15) and (16) for damaged threads.

c. Assembly

1 Assemble in reverse order of disassembly.

2 Replace two cotter pins (4) and four cotter pins (8).

3 Insure jaws (12) and (14) have been evenly spaced on bolt (13) during assembly.

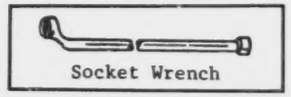
4 Insure hexhead on bolt (13) is installed on high side of mount base (11).

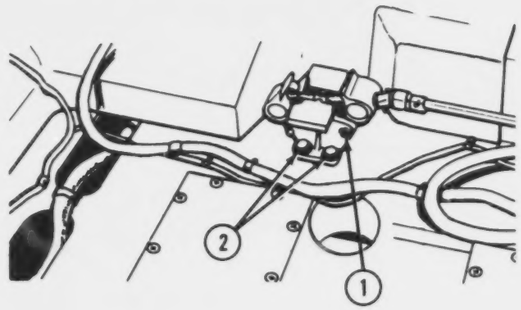
TA472177

ENGINE COMPONENTS - CONTINUED

5-6. ENGINE MOUNT BASE ASSEMBLY - CONTINUED

d. Installation


Socket Wrench



1 Install mount base assembly (1) and four screws (2) using socket wrench (Item 34, App. B).

2 Install powerplant (ref. p. 4-1).

5-7. SHOCK MOUNT AND BRACKET

This task covers:

a. Removal b. Installation

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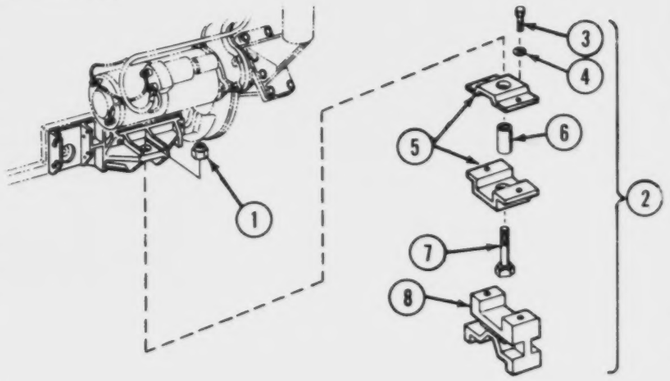
a. Removal



WARNING

Support powerplant before removing mount to avoid injury to personnel and damage to vehicle.

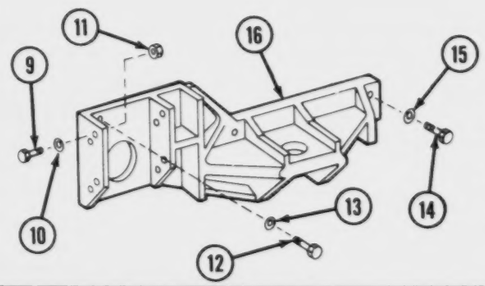
NOTE

Shock mount and bracket are located on lower rear of engine.

1 Remove powerplant (ref. p. 4-1).

2 Remove nut (1) and engine mount group (2).

3 Remove two screws (3) and two washers (4).



4 Separate two engine shock mount plates (5), spacer (6) and screw (7) from mount (8).

5 Remove eight screws (9), eight flatwashers (10) and eight nuts (11).

6 Remove three screws (12) and three washers (13).

7 Remove eight screws (14), eight washers (15) and bracket (16) from engine. Inspect mount and bracket for cracks.

b. Installation

1 Install in reverse order of removal.

2 Install eight screws (14), eight washers (15) and bracket (16) on engine. Torque screws to 60-65 lb-ft (81 to 88 Nm).

3 Install three screws (12) three washers (13). Torque to 35 lb-ft (47 Nm).

4 To install engine mount group (2), reverse order of removal.

TA472179

ENGINE COMPONENTS - CONTINUED

5-8. FUEL SHUT-OFF ASSEMBLY

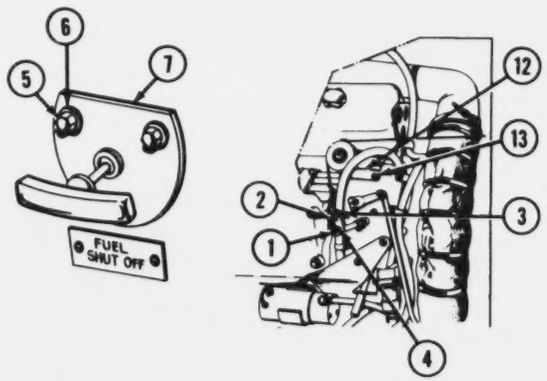
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Cotter pin

a. Removal



1 To remove fuel shut-off assembly, remove quick-release pin (1).

2 Remove cotter pin (2), clevis pin (3) and clevis lever (4). Discard cotter pin.

3 Remove three screws (5) and three lockwashers (6) at fuel shut-off control assembly (7), located in driver's compartment.

4 Deleted

5 Remove two screws (12) and pulley bracket (13).

TA472180

b. Installation

1 Install in reverse order of removal.

2 Replace cotter pin (2).

3 Inspect cable for deterioration.

4 Inspect pulley for wear or cracks.

CHAPTER 6
FUEL, AIR INTAKE AND EXHAUST SYSTEMS

GENERAL

This chapter illustrates and describes how to remove, disassemble, assemble, install and service the M109A2/M109A3/M109A4 Fuel, Air Intake and Exhaust systems.

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6-20 FUEL TANK HEAT SHIELD 6-40

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM

6-1. HOSES, TUBES AND FITTINGS

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Sealing compound (Item 47, App. C)
Defueling tanker (if required)

a. Removal

WARNING

Do not use open flame or smoke when working on the fuel system. An explosion may occur, causing severe injury or death.

1 Remove powerplant (ref. p. 4-1).

2 Drain fuel tanks (ref. TM 9-2350-311-10).

3 Remove hoses, tubes and fittings. Use illustration on page 6-4 as a reference guide.

b. Installation

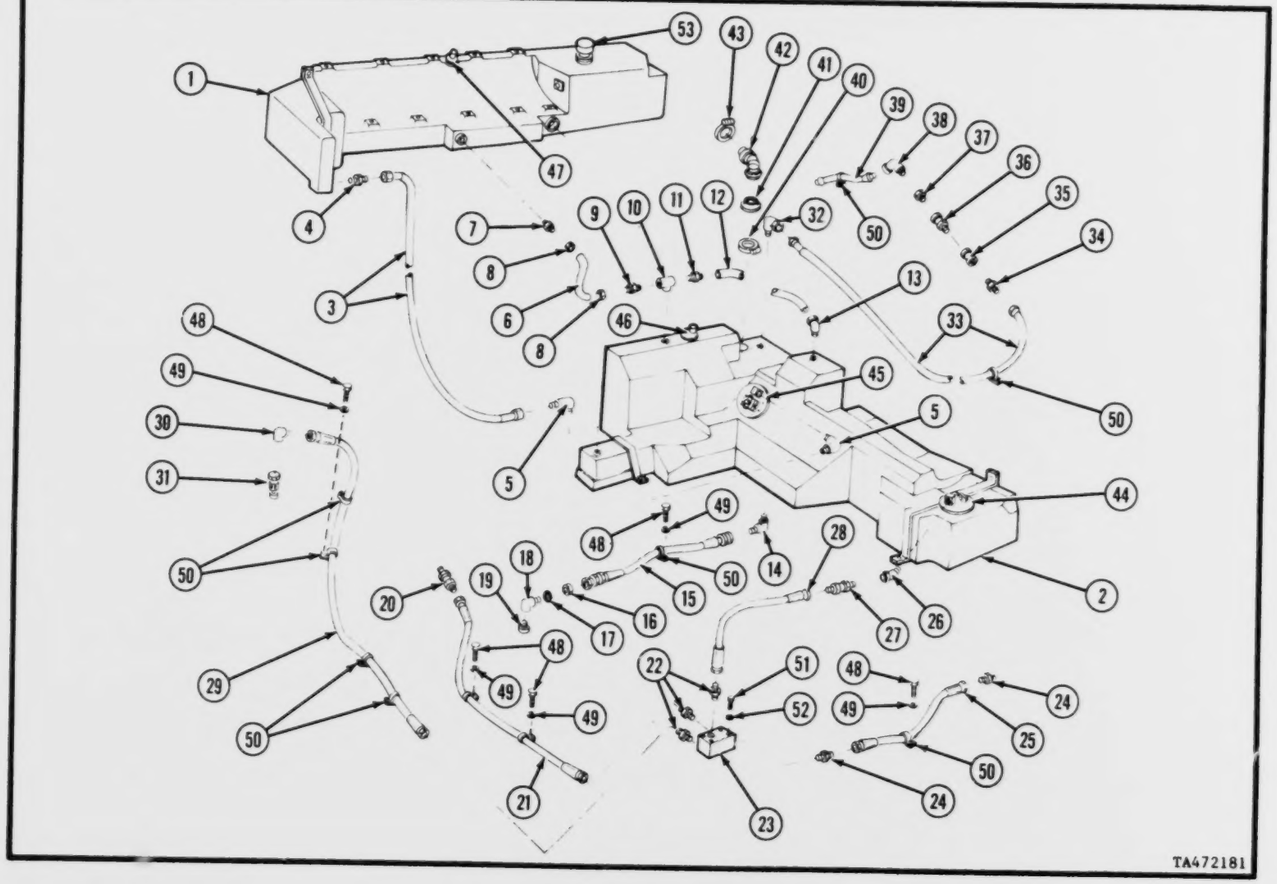
1 Install in reverse order of removal. Use illustration on page 6-4 as a reference guide.

2 During installation, use sealing compound (Item 47, App. C) on pipe threads (only).

3 Secure hose clamp (50) using existing screw on thermostat housing.

4 Tighten hose clamp (43) to 35 to 40 lb-in (3.5 to 4.5 Nm).

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED



LEGEND

1. Upper fuel tank
2. Lower fuel tank
3. Upper-to-lower fuel tank drain hose
4. Nipple
5. Elbow (2)
6. Upper-to-lower fuel tank breather hose
7. Adapter
8. Nut (2)
9. Adapter
10. Tee
11. Adapter
12. Lower fuel tank breather hose
13. Elbow
14. Elbow
15. Fuel tank drain hose
16. Nut
17. Washer
18. Elbow
19. Plug
20. Fuel pump discharge check valve
21. Fuel tank pump hose
22. Nipple (2)
23. Fuel distribution terminal fitting
24. Nipple (2)
25. Personnel heater hose
26. Elbow
27. Fuel pump discharge check valve
28. Fuel tank pump hose
29. Terminal fitting to primary fuel filter hose
30. Elbow
31. Coupler assembly
32. Elbow
33. Lower fuel tank return hose
34. Adapter
35. Coupler (female)
36. Coupler (male)
37. Adapter
38. Elbow
39. Engine to lower fuel tank
40. Coupling clamp
41. Hose flange
42. Upper-to-lower drain tank main drain
43. Hose clamp
44. Fuel pump
45. Fuel pump
46. Lower tank fuel level transmitter
47. Upper tank fuel level transmiter
48. Screw (10)
49. Lockwasher (10)
50. Loop clamp (10)
51. Screw (4)
52. Lockwasher (4)
53. Fuel tank filler neck and cap

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-2. FUEL TANK FILLER ASSEMBLY (CAP, SEAL AND FILLER)

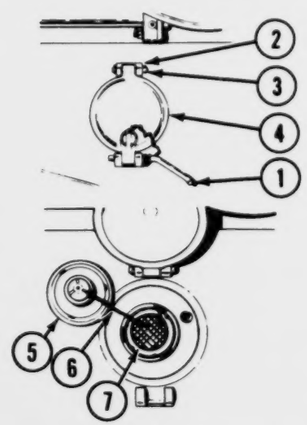
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Cotter pin, Solvent (Item 18, App. C)
Gasket (2 as required)

a. Removal



WARNING

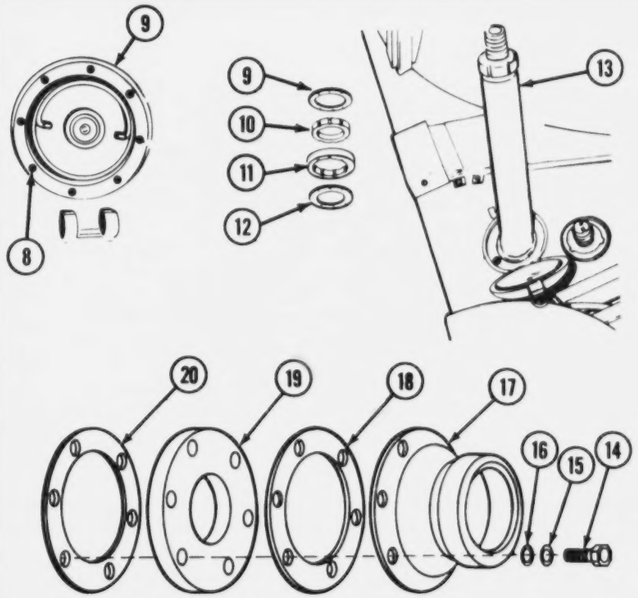
Do not smoke or use open flame when working on fuel system. An explosion may occur, causing severe injury or death.

1 Remove locking pin (1), cotter pin (2), straight pin (3) and cover (4). Discard cotter pin.

2 Open cover (4) and unscrew filler cap (5).

3 Unclip filler cap chain (6) from filler tube (7).

TA472182



4 Remove eight screws (8), top washer (9), outer seal (10), inner seal (11) and bottom washer (12) (items (9) through (12) can be removed as a unit).

5 Remove fuel filter screen (13). Clean with solvent (Item 18, App. C). Discard if torn.

6 Remove six screws (14), six flatwashers (15) and six lockwashers (16).

7 Remove filler neck (17), gasket (18), spacer (19), and gasket (20). Discard gaskets if torn or deteriorated.

b. Installation

1 Install in reverse order of removal.

2 Replace cotter pin (2).

3 Replace gaskets (18) and (20) as required.

4 Replace filter screen (if required).

TA472183

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-3. FUEL TANK LEVEL TRANSMITTERS (UPPER AND LOWER)

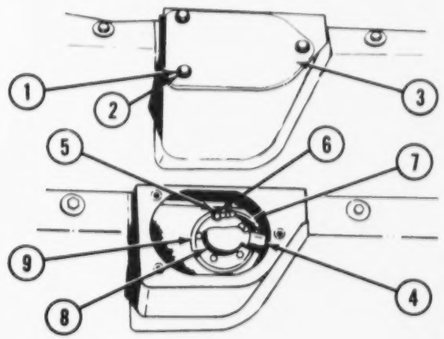
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Gaskets (2)

a. Removal



WARNING

Do not smoke or use open flame when working on the fuel system. An explosion may occur, causing severe injury or death.

1 Remove exhaust deflector and exhaust grille (ref. p. 4-9).

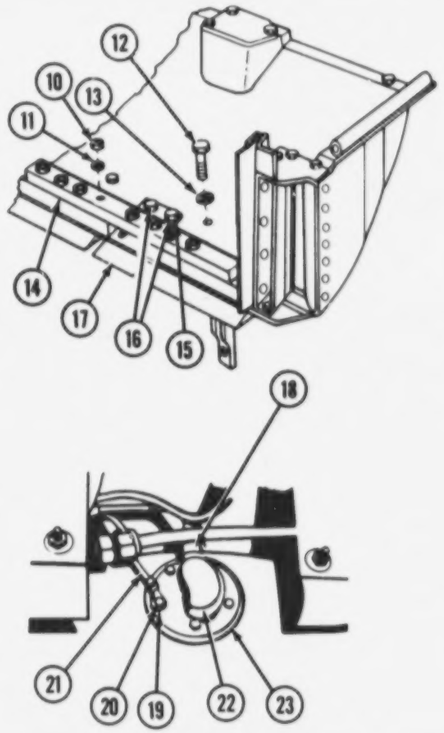
2 Remove three screws (1), three lockwashers (2) and cover (3).

3 Disconnect electrical connector (4).

4 Remove five screws (5), five lockwashers (6) and ground lead (7).

5 Remove transmitter (8) and gasket (9). Discard gasket.

TA472184



6 To remove lower fuel tank level transmitter, drain fuel tank (ref. TM 9-2350-311-10).

7 Remove six nuts (10), six washers (11), one screw (12), one flatwasher (13) and bar (14).

8 Remove two nuts (15), two flatwashers (16) and plate (17).

9 Remove electrical connectors (18).

10 Remove five screws (19), five lockwashers (20) and ground lead (21).

11 Remove transmitter (22) and gasket (23). Discard gasket.

b. Installation

1 Install in reverse order of removal.

2 Replace gaskets (23) and (9).

TA472185

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-4. FUEL CHECK VALVES

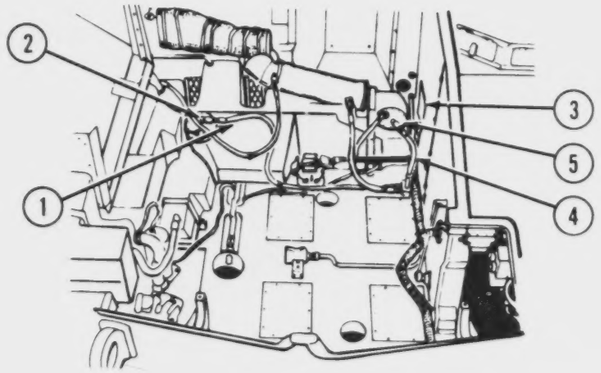
This task covers:

a. Removal b. Installation

a. Removal

WARNING

Do not smoke or use open flame when working on fuel systems. An explosion may occur, causing severe injury or death.



The powerplant does not have to be removed to remove left check valve.

1 Remove powerplant (ref. p. 4-1).

2 Drain fuel tanks (ref. TM 9-2350-311-10).

3 Disconnect fuel hose (1) at right check valve (2).

4 Remove right check valve from pump assembly.

TA472186

5 Remove engine compartment access door (3) (ref. p. 4-16).

6 Drain fuel tanks (ref. TM 9-2350-311-10).

7 Remove fuel hose (4) at left check valve (5).

8 Remove left check valve (5) from pump assembly.

b. Installation

Install in reverse order of removal.

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-5. ELECTRIC FUEL PUMPS

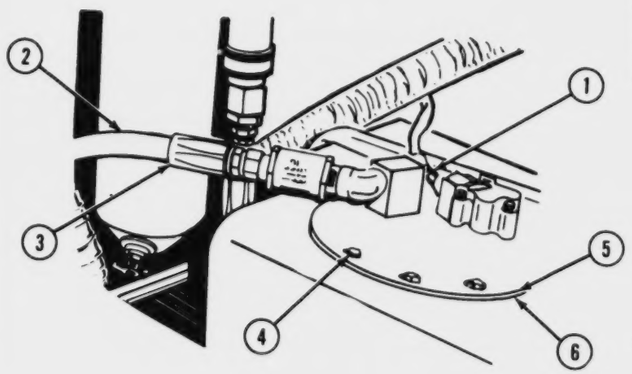
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Gaskets (2)

b. Removal



WARNING

Do not smoke or use open flame when working on fuel systems. An explosion may occur, causing serious injury or death.

NOTE

Powerplant needs to be removed for right electric fuel pump only. Left fuel pump requires the removal of the engine compartment access cover.

1 To remove right electric fuel pump, remove powerplant (ref. p. 4-1).

2 Disconnect electrical connector (1).

3 Remove fuel hose (2) and check valves (3).

TA472187

4 Remove ten screws (4), fuel pump assembly (5) and gasket (6). Discard gasket.

5 For removal of left electric fuel pump remove engine compartment access cover.

6 Disconnect electrical connector (1).

7 Remove fuel hose (2) and check valve (3).

8 Remove ten screws (4), fuel pump assembly (5) and gasket (6). Discard gasket.

b. Installation

1 Install right or left electric fuel pump in reverse order of removal.

2 Replace gaskets (6).

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-6. PRIMARY FUEL FILTER

This task covers:

a. Removal b. Installation

INITIAL SET-UP

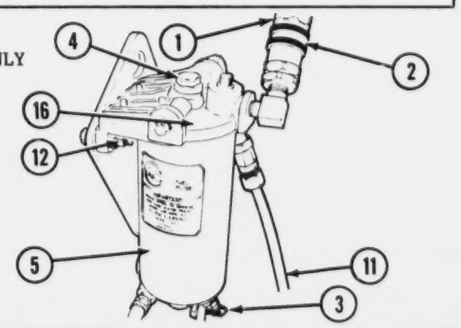
Materials/Parts
Gasket, Filter

a. Removal

WARNING

Do not smoke or use open flame when working on fuel system.

M109A2 ONLY



NOTE

Primary fuel filter assembly does not need to be removed from vehicle to remove filter element.

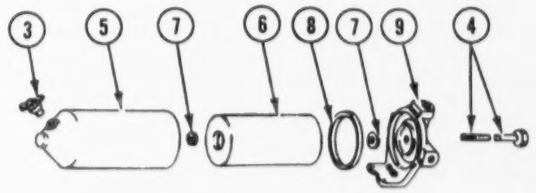
Access to the primary filter assembly differs in the M109A2 and M109A3:

A. Access primary filter through right transmission access door in the M109A2 (ref. p. 4-11).

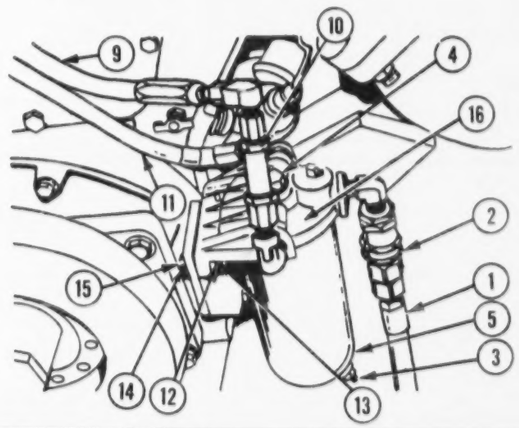
B. Access primary filter through engine compartment access door in M109A3 (ref. p. 4-16).

1 Disconnect main fuel hose (1) at quick disconnect (2).

TA472188



M109A3 ONLY



NOTE

If the M109A3 vehicle has a drain hose/tube draincock located in the area around the secondary fuel filter, drain in front of vehicle.

2 Open draincock (3) by turning and drain fuel.

3 Loosen cover screw (4).

4 Remove filter shell (5), filter element (6), two washers (7) and gasket (8). Discard gasket. Discard filter element if necessary.

NOTE

Continue removal process only if complete primary fuel filter assembly removal is necessary.

5 Disconnect primary filter to engine-driven fuel pump tube (9) at adapter on outlet end of check valve (10).

6 Disconnect primary filter to air box heater hose (11).

7 Remove two nuts (12), two flatwashers (13), two lockwashers (14) and two screws (15). Remove filter cover (16).

b. Installation

1 Install in reverse order of removal.

2 Replace gasket (5) and filter element (6) (if necessary).

TA472189

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-7. SECONDARY FUEL FILTER

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Gasket
Filter

a. Removal

WARNING

Do not smoke or use open flame when working on fuel system.
An explosion may occur, causing severe injury or death.

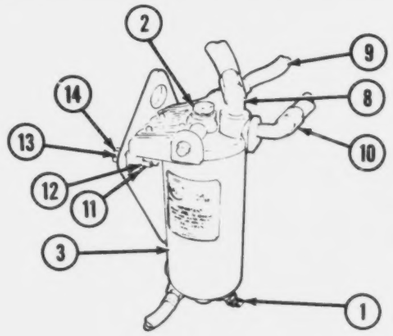
NOTE

Secondary fuel filter assembly does not need to be removed from vehicle to remove filter element.

1 Open left transmission door (ref. p. 4-10).

2 Open drain cock (1) by turning and drain fuel from filter.

3 Loosen cover screw (2).



4 Remove filter shell (3), filter element (7), two washers (4), and gasket (5) from cover (6). Discard gasket. Discard filter element if necessary.

NOTE

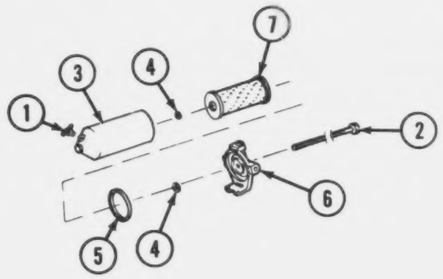
Continue removal process only if complete removal of secondary fuel filter assembly is necessary.

5 Disconnect electric fuel pump to secondary fuel filter hose (8) at fuel filter.

6 Disconnect secondary fuel filter to cylinder head tube (9) at filter.

7 Disconnect engine driven fuel pump at secondary fuel filter tubes (10) at filter.

8 Remove two nuts (11), two flatwashers (12), two lockwashers (13) and two screws (14) to remove secondary fuel filter assembly.



b. Installation

1 Install in reverse order of removal.

2 Replace gasket (5) and filter element (7) (if necessary).

TA472190

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-8. ENGINE DRIVEN FUEL PUMP

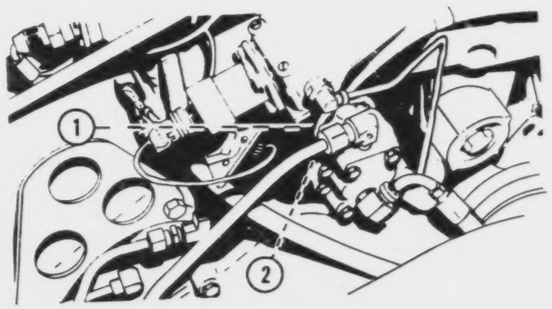
This task covers:

a. Shaft check b. Removal c. Installation

INITIAL SET-UP

Materials/Parts
Gasket

a. Shaft check

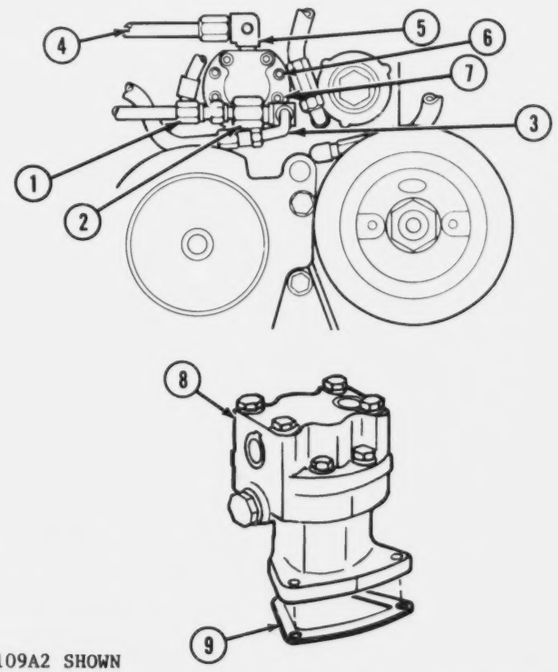


M109A3 SHOWN

Check for a broken shaft by removing top pump body drain plug (1) (hidden). Insert a small wire (approximate length and size of a straightened paper clip) in pump body hole (2) (hidden). Rotate shaft by cranking engine momentarily. If vibration is felt, shaft is good. If no vibration is felt, replace pump.

TA472191

b. Removal



M109A2 SHOWN

WARNING

Do not smoke or use open flame when working on fuel system. An explosion may occur, causing severe injury or death.

1 Open air intake grille and secure (ref. p. 4-8).

2 Remove exhaust grille, radiator fan access door and front slope plate (ref. p. 4-9 and 4-10).

3 Remove exhaust crossover tube (ref. p. 6-36).

4 Disconnect primary filter to engine driven fuel pump tube (1) at tee (2) (ref p. 6-24).

5 Disconnect engine-driven fuel pump to electric fuel pump hose (3) (ref.p. 6-24).

6 Disconnect engine-driven fuel pump to secondary filter tube (4) at elbow (5).

7 Remove three screws (6) and three lockwashers (7).

8 Remove fuel pump (8) and gasket (9). Discard gasket.

c. Installation

1 Install in reverse order of removal.

2 Replace gasket (9).

TA472192

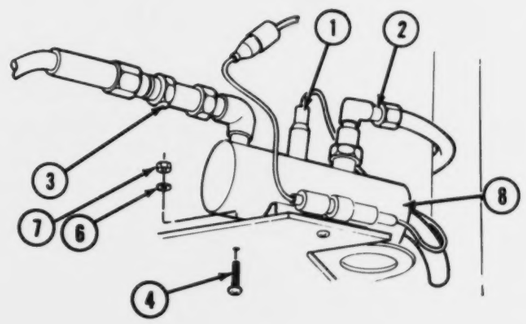
FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-9. ELECTRICALLY DRIVEN FUEL PUMP

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Do not smoke or use open flame when working on fuel system. An explosion may occur, causing severe injury or death.

1 Open air intake door and secure in place.

2 Remove front slope plate (ref. p. 4-10).

3 Disconnect electrical connector (1).

4 Disconnect engine-driven fuel pump to electrical fuel pump hose (2).

TA472193

5 Disconnect electric fuel pump to secondary filter hose (3).

6 Remove two screws (4), two lockwashers (6) and two nuts (7).

7 Remove electrically-driven fuel pump (8).

b. Installation

Install in reverse order of removal.

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-10. RELIEF VALVE

This task covers:

Checking and Cleaning

INITIAL SET-UP

Materials/Parts
Gaskets (2)
Solvent (Item 19, App. C)

Checking and Cleaning

WARNING

Do not smoke or use open flame when working on fuel systems. An explosion may occur, causing severe injury or death.

1 Remove relief valve assembly (7) (components 2 through 5) and wash with solvent (Item 19, App. C). Discard gasket (2).

2 Blow out fuel pump cavity port (6) with compressed air.

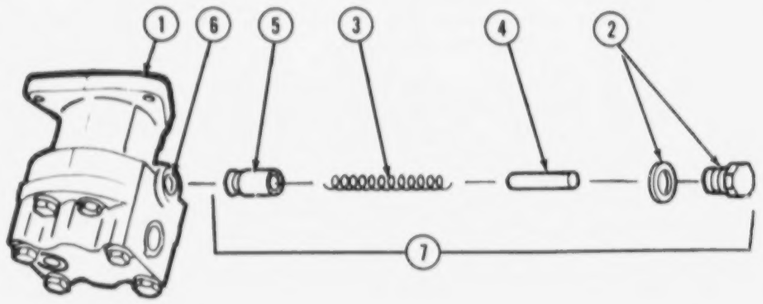
3 Reassemble relief valve assembly (7). Install new gasket (2).

4 Install relief valve assembly (7) in engine driven fuel pump.

5 Test for fuel flow (ref. p. 6-26).

NOTE

If flow is less than 1/2 gallon per minute, replace pump (ref. p. 6-18).



TA472194

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION I. FUEL SYSTEM - CONTINUED

6-11. POWERPLANT FUEL HOSES, TUBES AND FITTINGS

This task covers:

a. Removal b. Installation

a. Removal

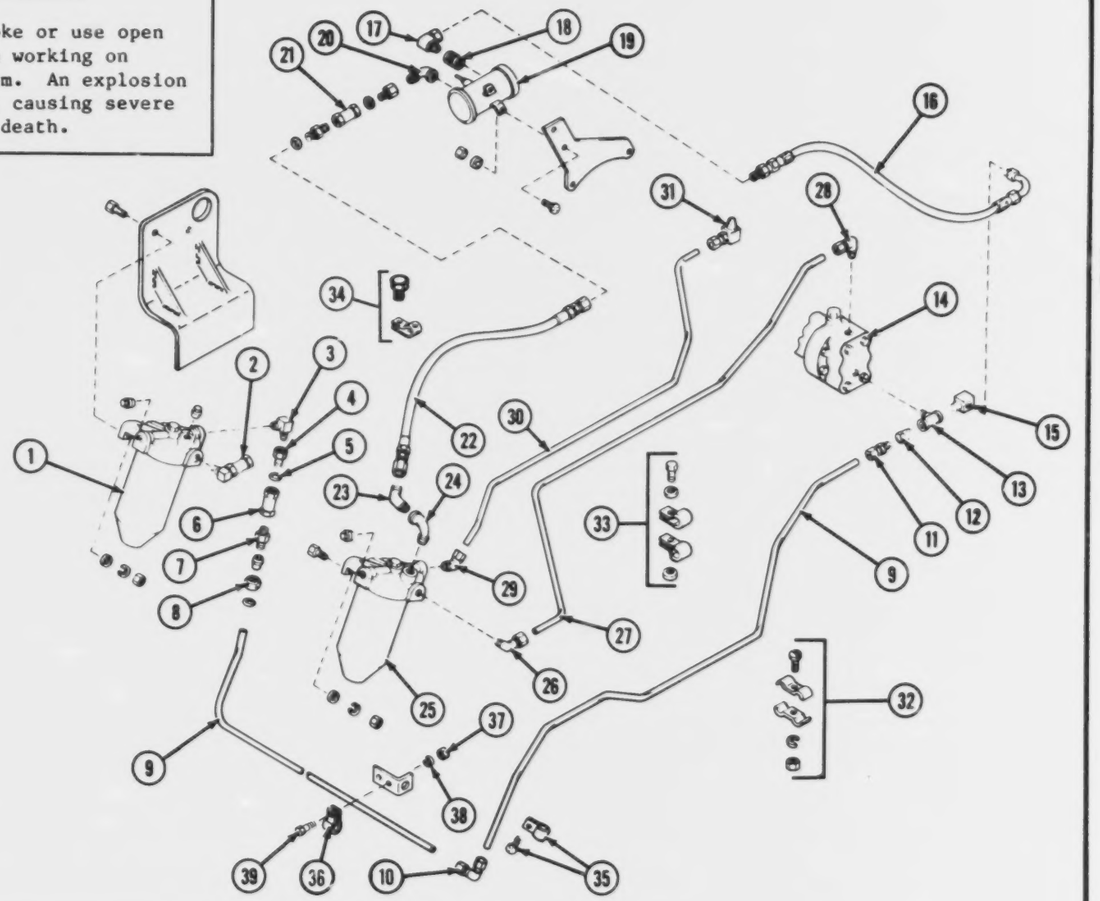
NOTE

Restrict removal to only those hoses and tubes which must be replaced.
Use the legend and fuel system diagram as a reference guide only.

1. Primary fuel filter
2. Fuel tank to primary filter hose connector
3. Elbow
4. Adapter
5. Preformed packing
6. Check valve
7. Sleeve
8. Nut
9. Primary fuel filter to engine-driven fuel pump tube
10. Elbow
11. Adapter
12. Bushing
13. tee
14. Engine-driven fuel pump
15. Elbow
16. Engine-driven pump to electric fuel pump
17. Elbow
18. Coupler
19. Electric fuel pump
20. Elbow
21. Check valve adapter and union assembly
22. Electric fuel pump to secondary filter hose assembly
23. Elbow
24. Elbow
25. Secondary filter
26. Elbow
27. Engine-driven fuel pump to secondary filter tube assembly
28. Elbow
29. Elbow
30. Secondary filter to engine cylinder heads tube assembly
31. Engine hose connector tube assembly
32. Tube clamp assembly (2)
33. Tube attaching strap assembly (6)
34. Tube attaching strap assembly
35. Tube attaching strap assembly
36. Tube attaching strap
37. Nut
38. Lockwasher
39. Screw

WARNING

Do not smoke or use open flame when working on fuel system. An explosion may occur, causing severe injury or death.



6-12. FUEL FLOW TEST

This task covers:

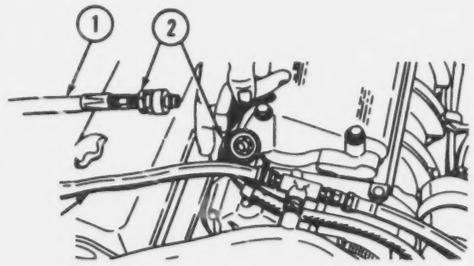
Test

INITIAL SET-UP

Special Tools
Watch (timer), Container

Materials/Parts
Fuel filter element, Container

Test



WARNING

Do not smoke or use open flame when working on fuel systems. An explosion may occur, causing severe injury or death.

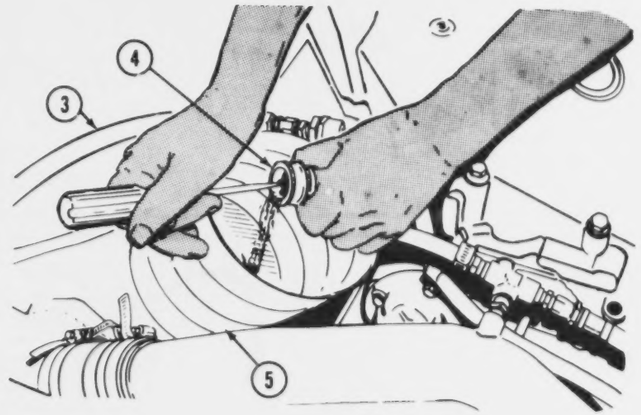
1 Check quick-disconnect (2) to be certain main fuel hose (1) is fully seated.

2 Install new fuel filter elements (ref. p. 6-14 and 6-16).

3 Open air intake grille and secure in raised position (ref. p. 4-8).

4 Start engine and warm up to 170°F (77°C) (ref. TM 9-2350-311-10).

TA472196



5 Disconnect fuel return hose (3) from quick-disconnect (4).

CAUTION

Ensure valve in quick-disconnect is pushed all the way in during the test.

6 Place female half of quick-disconnect (4) in container (5) to catch fuel.

7 Set engine at 1200 RPM.

8 Depress valve of female connector of quick-disconnect (4) for 1 minute. Measure the fuel container (5). If fuel flow is less than 1/2 gallon (1.9 liter) per minute, remove exhaust crossover pipe and check for broken shaft in fuel pump (ref. p. 6-18) or dirt in relief valve (ref. p. 6-22).

9 Reconnect fuel return hose (3) at quick-disconnect (4).

TA472197

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION II. AIR INTAKE SYSTEM

6-13. AIR CLEANER

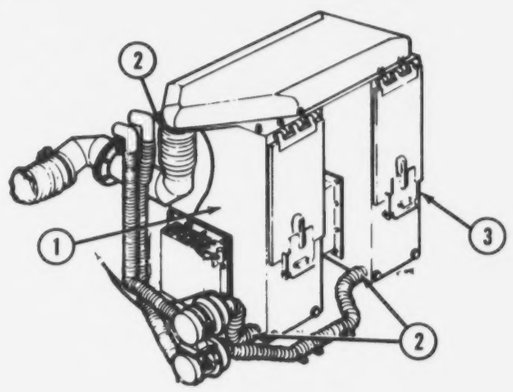
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Gaskets (8)
Adhesive (Item 5 or 6, App. C)

a. Removal

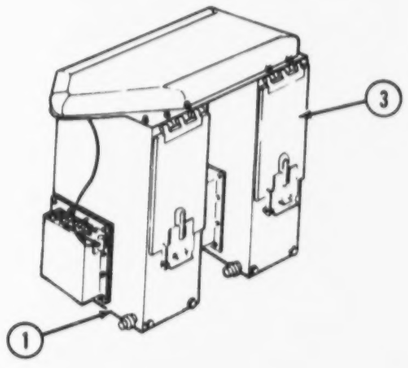


1 Remove fuze packs (ref. TM 9-2350-311-10) from in front of left air cleaner box (1).

2 Remove filter packs (ref. p. 6-33).

3 Disconnect three air inlet ducts and hoses (2) at left and right air cleaners (1) and (3) (ref. p. 6-34).

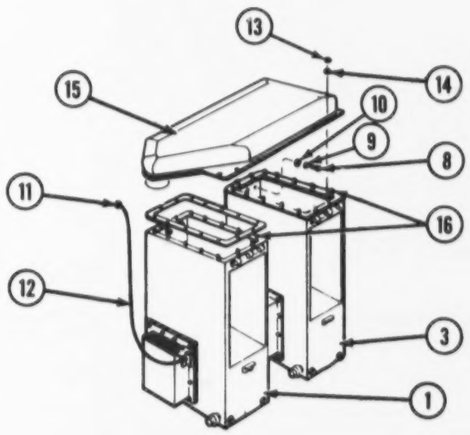
TA472198



4 Deleted.

CAUTION

Place 2 X 4 supports under air cleaner boxes before proceeding to step 5.



5 Remove eight screws (8), eight lockwashers (9) and eight flatwashers (10).

CAUTION

Support air cleaner duct (15) while removing left and right air cleaner boxes (1) and (3).

6 Remove 2 x 4 supports and lower boxes to hull deck.

7 Loosen nut (11) at air cleaner duct (15) to disconnect hose (12).

8 Remove 28 nuts (13) and 28 flatwashers (14).

9 Lift air cleaner duct (15) clear of lugs (16). Air cleaner duct must be removed to permit removal of boxes.

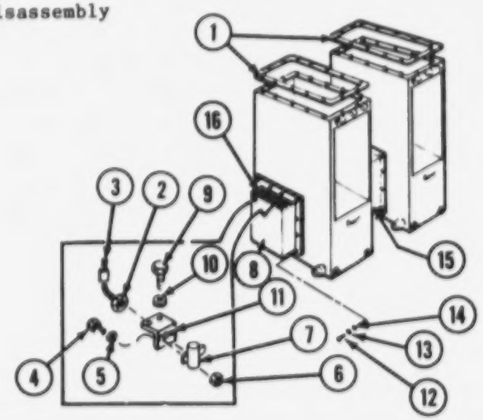
10 Remove left and right air cleaner boxes (1) and (3).

TA472199

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION II. AIR INTAKE SYSTEM - CONTINUED

6-13. AIR CLEANER - CONTINUED

b. Disassembly



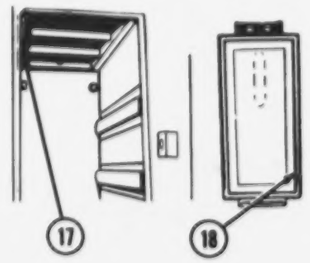
1 Remove two gaskets (1). Discard gaskets.

2 Loosen nut (2) to disconnect hose (3).

3 Remove two screws (4), two washers (5) and two nuts (6) and indicator (7) from left box assembly (8).

4 Remove two screws (9) and two washers (10) and bracket (11) from left box assembly (8).

5 Remove 20 screws (12), 20 lockwashers (13) 20 flatwashers (14), two box assemblies (8 and 15) and two gaskets (16). Discard two gaskets.



6 Remove two gaskets (17) and two gaskets (18). Discard all gaskets.

TA472200

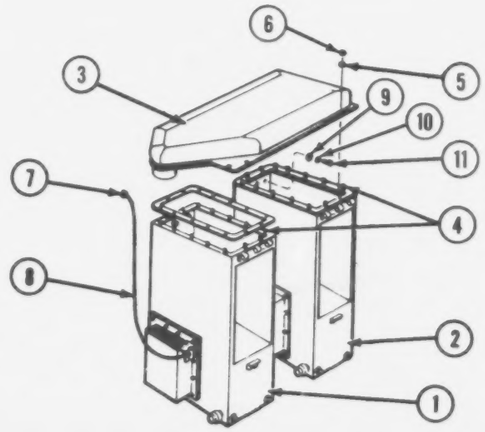
c. Assembly

1 Assemble in reverse order of disassembly.

2 Replace two gaskets (16), and two gaskets (1).

3 Apply adhesive (Item 5 or 6, App. C) in recess of air cleaner and door, and replace two gaskets (18) and two gaskets (17).

d. Installation



1 Position left and right air cleaner boxes (1 and 2) so air cleaner duct (3) can be installed.

2 Place air cleaner duct (3) over lugs (4) and install 28 flatwashers (5) and 28 nuts (6).

3 Tighten nut (7) at air cleaner duct (3) to secure disconnect hose (8).

NOTE

2 X 4 supports under air cleaner boxes may help position assembly for installation.

4 Position air cleaner boxes on hull wall to install and secure using eight flatwashers (9), eight lockwashers (10) and eight screws (11).

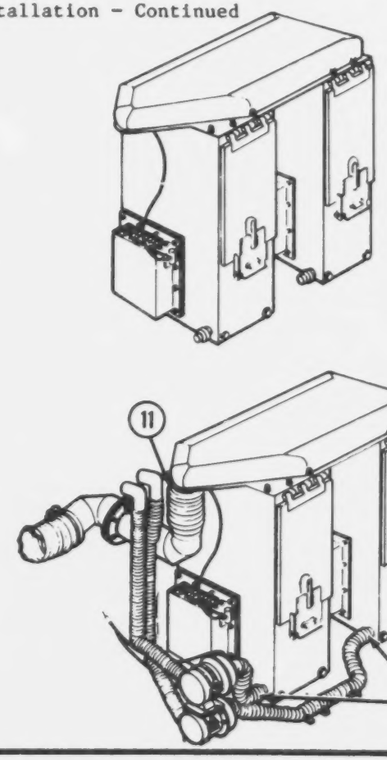
5 Remove 2 X 4 supports if necessary.

TA472201

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION II. AIR INTAKE SYSTEM - CONTINUED

6-13. AIR CLEANER - CONTINUED

d. Installation - Continued



6 Deleted.

7 Connect three air inlet ducts and hoses (11) at air cleaner (ref. p. 6-34).

8 Install filter packs (ref. p. 6-33).

9 Install fuze packs (ref. TM 9-2350-311-10).

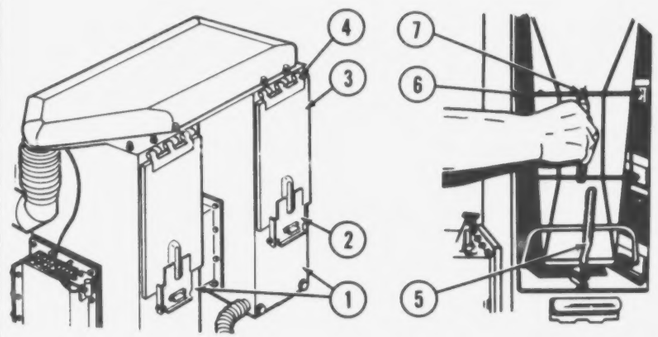
TA472202

6-14. AIR CLEANER FILTER

This task covers:

a. Removal b. Installation

a. Removal



NOTE

Follow step 1 for the M109A3 only.

1 Remove ammo pack from brackets from some M109A3s. Remove M63 rack on later versions.

NOTE

Follow step 2 for the M109A2 only.

2 Remove 155MM projectiles and bracket (ref. p. 12-2).

3 Pull down on locking latch (2), open door (3) slightly, and lift off hinge (4) and door.

4 Pull downward on filter pack locking lever (5) to release filter pack (6).

5 Pull on filter pack removal handle (7) to remove filter pack (6) from air cleaner boxes (1).

b. Installation

Install in reverse order of removal.

TA472203

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION II. AIR INTAKE SYSTEM - CONTINUED

6-15. DUCTS AND HOSES

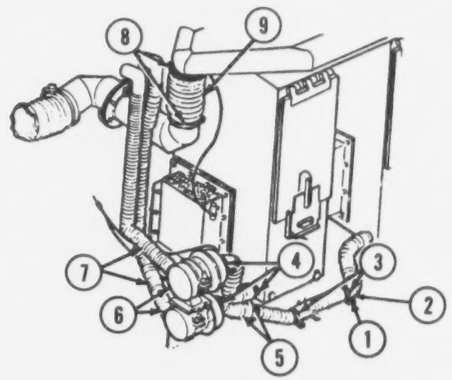
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Gasket

a. Removal



1 Remove two screws (1), two lockwashers (2) and two mounting clamps (3).

2 Loosen four hose clamps (4).

NOTE

For removal and installation of blower motors, (ref. p. 6-37).

3 Remove two air-cleaner-to-duct-exhaust hoses (5).

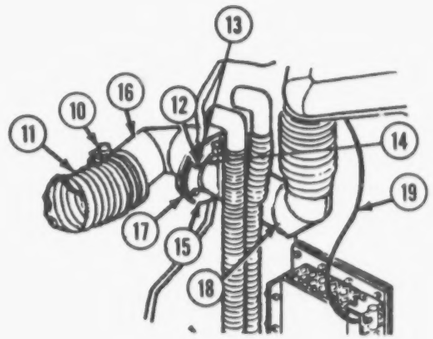
4 Loosen two hose clamps (6).

5 Remove two duct exhaust to elbow hoses (7).

6 Loosen two hose clamps (8).

7 Remove air cleaner duct to elbow duct hose (9).

TA472204



NOTE

Powerplant must be removed to remove air intake duct, elbow duct and flange assembly (ref. p. 4-1).

8 Remove hose clamp (10) and turbocharger air intake duct hose (11).

9 Remove six screws (12), six lockwashers (13) and six flatwashers (14) at powerplant compartment bulkhead and separate elbow duct flange assembly (15).

10 Remove elbow duct (16). Remove gasket (17).

11 Remove elbow duct (18) by pulling through bulkhead into powerplant compartment.

12 Remove indicator hose (19).

b. Installation

Install in reverse order of removal.

TA472205

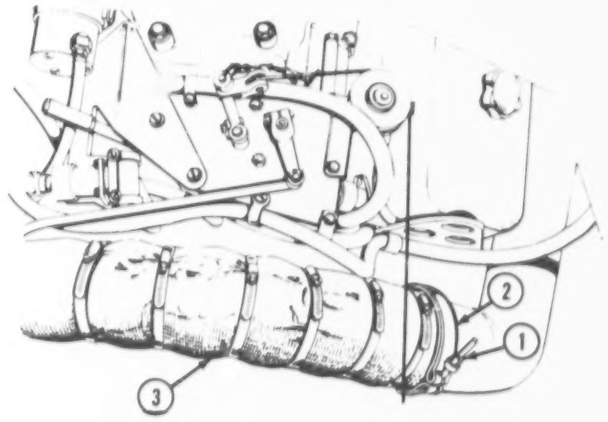
FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION III. EXHAUST SYSTEM

6-16. EXHAUST CROSSOVER TUBE

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Insure engine and exhaust sytems are cool enough to permit handling in order to prevent burns.

1 Open air intake grille (ref. p. 4-8).

2 Remove exhaust grille and radiator fan access door (ref. p. 4-9 and 4-10).

3 Disconnect throttle governor at bell crank (ref. p. 9-49).

4 Remove two nuts (1) and two clamps (2) at ends of pipe.

5 Remove exhaust crossover tube (3).

b. Installation

Install in reverse order of removal.

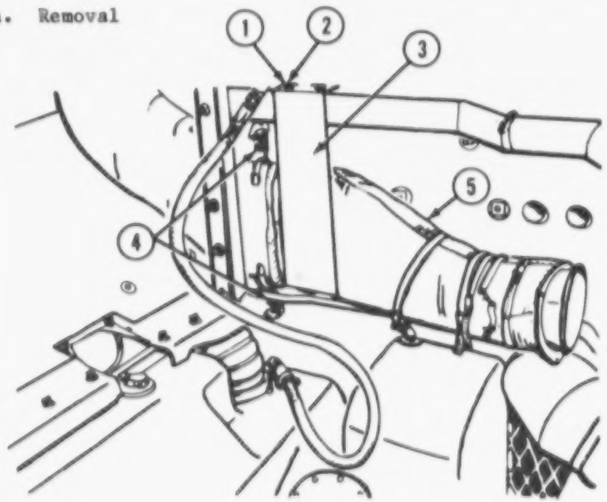
TA472206

6-17. EXHAUST DUCT AND BUFFER PLATE

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Insure engine and exhaust systems are cool enough to permit handling in order to prevent burns.

1 Remove powerplant (ref. p. 4-1).

2 Remove two screws (1), two lockwashers (2) and buffer plate (3) (applicable only to earlier M109A3 vehicles).

3 Disconnect two springs (4).

4 Remove exhaust duct (5).

b. Installation

Install in reverse order of removal.

TA472207

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION III. EXHAUST SYSTEM - CONTINUED

6-18. EXHAUST BYPASS PIPE

This task covers:

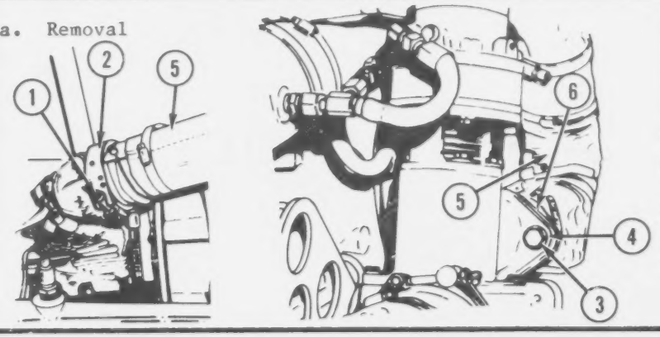
a. Removal b. Installation

INITIAL SET-UP

Applicable Configuration
M109A3 only

Materials/Parts
Gasket

a. Removal



WARNING

Insure engine and exhaust systems are cool enough to permit handling in order to prevent burns.

1 Remove powerplant (ref. p. 4-1).

2 Remove nut (1) and clamp (2).

3 Remove two screws (3) and two lockwashers (4). Remove exhaust bypass pipe (5) and gasket (6). Discard gasket.

b. Installation

1 Install in reverse order of removal.

2 Replace gasket (6).

TA472208

6-19. EXHAUST OUTLET PIPE

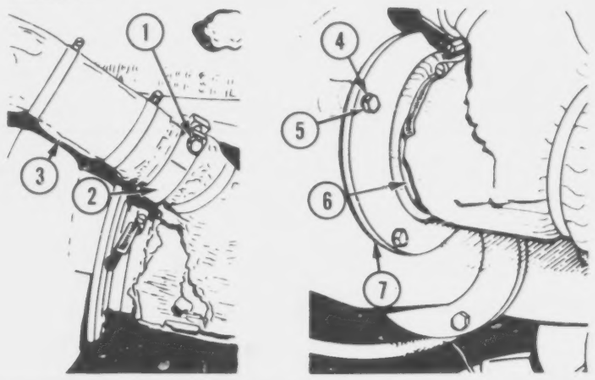
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Applicable Configuration	Materials/Parts
M109A3 only	Gasket

a. Removal



WARNING

Insure engine and exhaust systems are cool enough to permit handling in order to prevent burns.

1 Remove powerplant (ref. p. 4-1).

2 Remove clamp nut (1) and clamp (2). Disconnect exhaust bypass pipe (3).

3 Remove four screws (4), four lockwashers (5), exhaust outlet pipe (6) and gasket (7). Discard gasket.

b. Installation

1 Install in reverse order of removal.

2 Replace gasket (7).

TA472209

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION IV. FUEL TANK HEAT SHIELD

6-20. FUEL TANK HEAT SHIELD

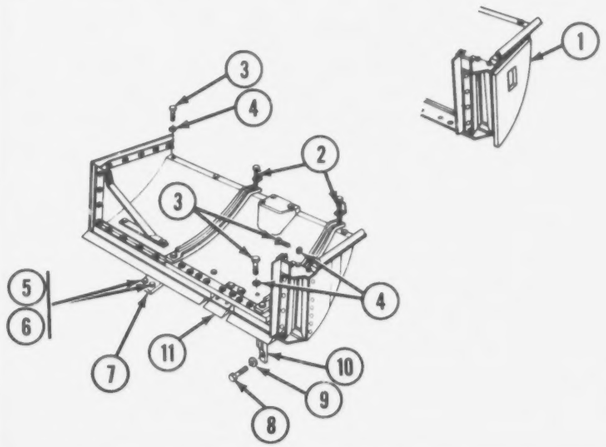
This task covers:

a. Removal b. Disassembly c. Assembly e. Installation

INITIAL SET-UP

Materials/Parts	Personnel Required
Sealing Compound (Item 44, App. B)	2

a. Removal



1 Remove exhaust pipe (ref. p. 6-37).

CAUTION

Make certain while removing fuel tank heat shield pad (1) to avoid damage to fuel tanks.

2 Remove fuel tank heat shield pads (1).

3 Loosen t screws and two jamnuts (2).

4 Remove crews (3) and 11 flatwashers (4).

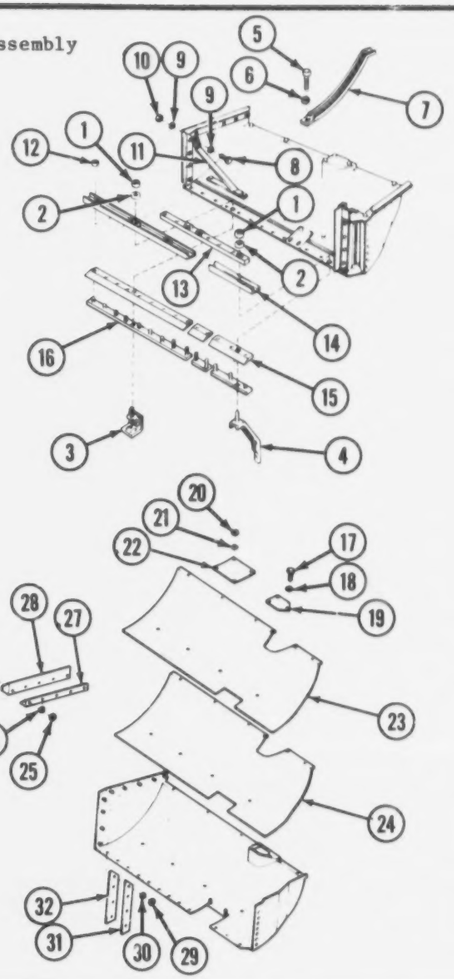
4 Remove two screws (5) and two flatwashers (6) from support (7).

5 Remove screw (8) and flatwasher (9) from support (10).

6 Remove fuel tank heat shield (11) from vehicle.

TA472527

b. Disassembly



1 Remove two nuts (1), two flatwashers (2) and two supports (3) and (4).

2 Remove two screws (5), two flatwashers (6) and two stiffeners (7).

3 Remove two screws (8), four washers (9), two nuts (10) and support (11).

4 Remove 14 nuts (12), bar (13), two stiffeners (14), three seal segments (15) and three retainer segments (16).

5 Remove three screws (17), three washers (18) and cover (19).

6 Remove two nuts (20), two washers (21) and cover (22).

7 Remove retainer (23) and insulation (24).

8 Remove five nuts (25), five washers (26), seal (27) and plate (28).

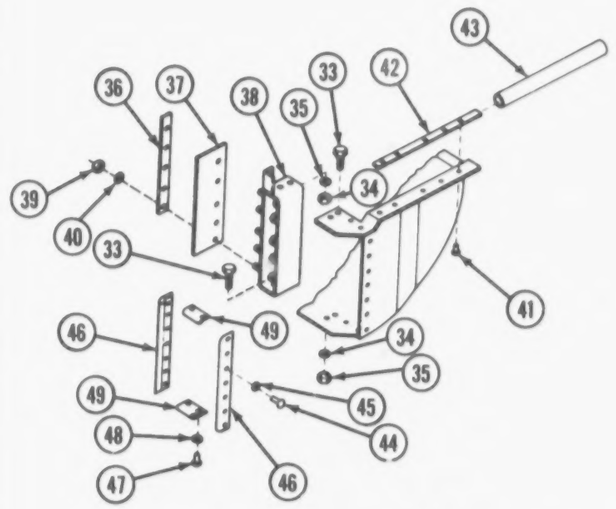
9 Remove four nuts (29), four washers (30), seal (31) and plate (32).

TA472528

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION IV. FUEL TANK HEAT SHIELD - CONTINUED

6-20. FUEL TANK HEAT SHIELD - CONTINUED

b. Disassembly - Continued



10 Remove four screws (33), four nuts (34) and four washers (35) to remove plate (36), seal (37) and retainer (38).

11 Remove five nuts (39) and five washers (40) to separate plate (36), seal (37) and retainer (38).

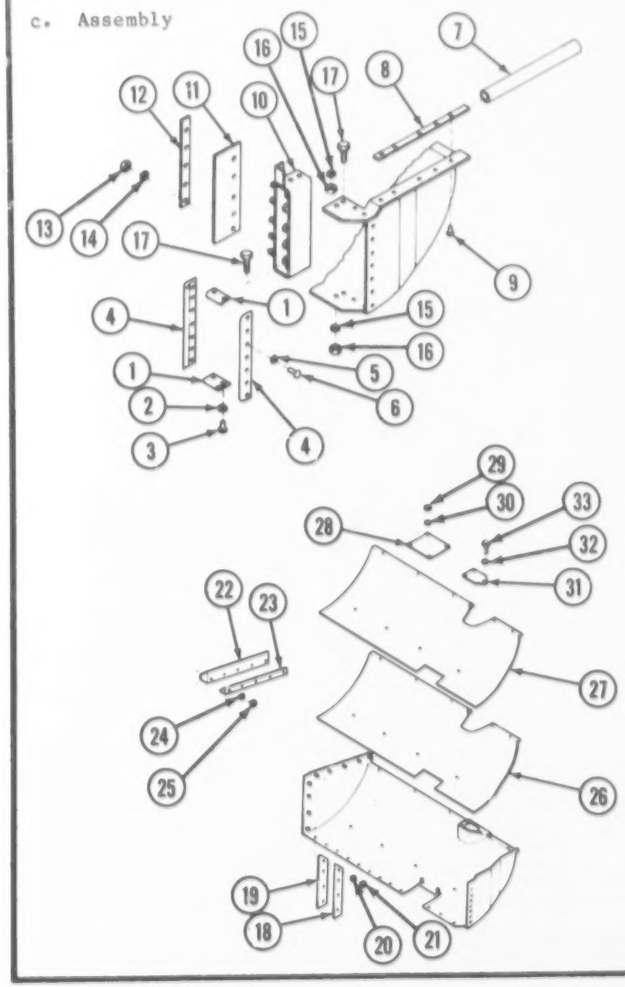
12 Remove five rivets (41), plate (42) and seal (43). Drill out rivets.

13 Remove seven rivets (44), seven flatwashers (45) and two seals (46). Drill out rivets.

14 Remove two rivets (47), two flatwashers (48) and two seals (49). Drill out rivets.

TA472529

c. Assembly



1 Install two seals (1), two flatwashers (2) and two rivets (3).

2 Install two seals (4), seven flatwashers (5) and seven rivets (6).

3 Install seal (7), plate (8) and five rivets (9).

4 Install retainer (10), seal (11), plate (12) five nuts (13) and five washers (14).

5 Install four washers (15), four nuts (16) and four screws (17).

6 Install plate (18), seal (19), four washers (20) and four nuts (21).

7 Install plate (22), seal (23), five washers (24) and five nuts (25).

8 Install insulation (26) and retainer (27).

9 Install cover (28), two nuts (29) and two washers (30).

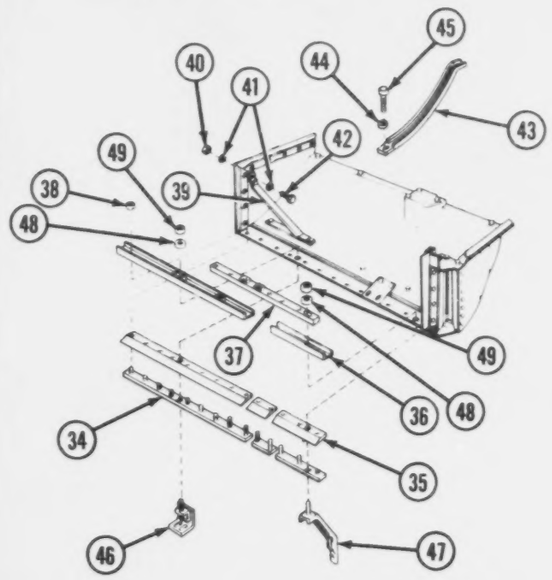
10 Install cover (31), three washers (32) and three screws (33).

TA472530

FUEL, AIR INTAKE AND EXHAUST SYSTEMS - SECTION IV. FUEL TANK HEAT SHIELD - CONTINUED

6-20. FUEL TANK HEAT SHIELD - CONTINUED

c. Assembly - Continued



11 Install three retainer segments (34), three seal segments (35), two stiffeners (36), bar (37) and 14 nuts (38).

12 Install support (39), two nuts (40), four washers (41) and two screws (42).

13 Install two stiffeners (43), two flatwashers (44) and two screws (45).

14 Install two supports (46) and (47), two flatwashers (48) and two nuts (49).

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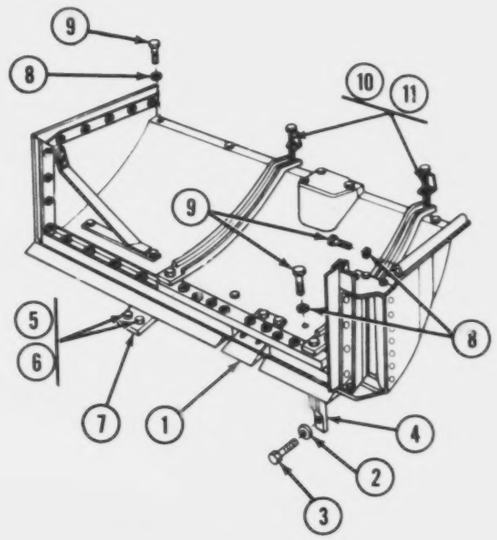
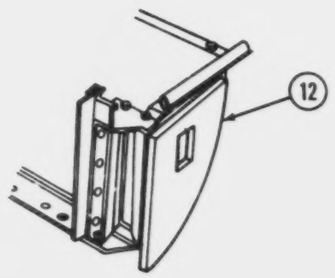
d. Installation





1 Install tank heat shield back onto vehicle (1).

2 Install flatwasher (2) and screw (3) onto support (4).

3 Install two flatwashers (5) and two screws (6) onto support (7).

4 Install 11 flatwashers (8) and 11 screws (9). Apply sealing compound (Item 47, App. C).

5 Tighten two jamnuts (10) and two screws (11).

6 Install fuel tank heat shield pad (12).

7 Install exhaust pipe (ref. TM 9-2350-311-20-1).

TA472532

CHAPTER 7
COOLING SYSTEM

GENERAL

This chapter illustrates and provides specific instructions for maintenance, removal, installation and cleaning of engine cooling system components.

CONTENTS

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7-5	RADIATOR AND SHROUD	7-15
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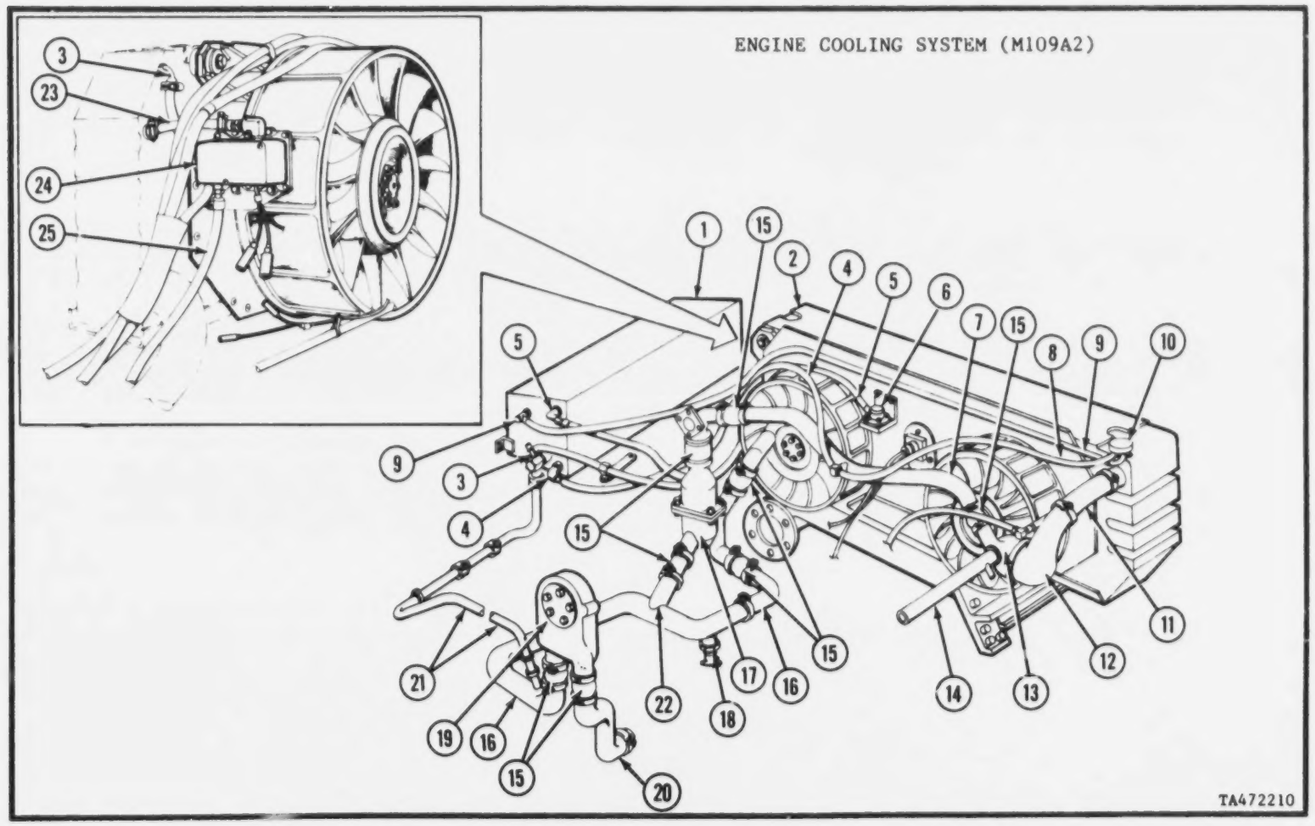
COOLING SYSTEM

7-1. ENGINE COOLING SYSTEMS, PICTORIAL



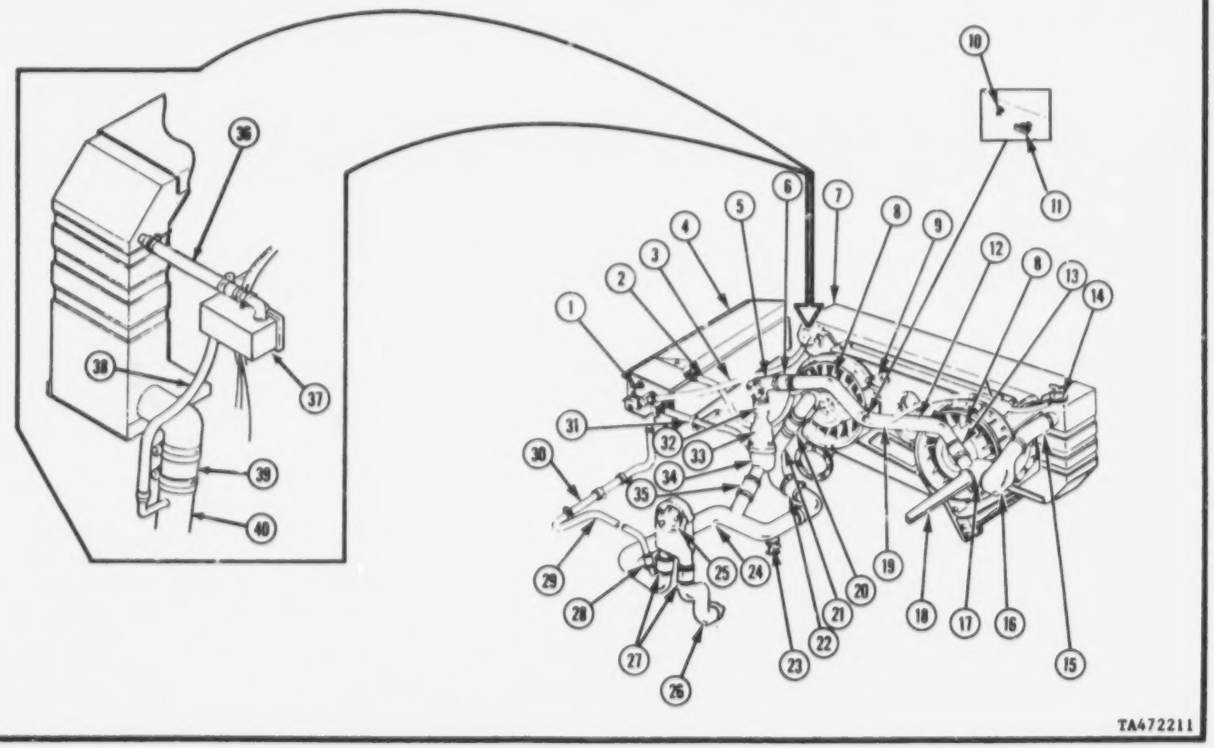
LEGEND

1. Surge tank
2. Radiator
3. Radiator-to-surge tank hose
4. Engine coolant cross-over tube-to-surge tank hose
5. Surge tank-to-pressure relief valve hose
6. Pressure relief valve assembly
7. Engine coolant cross-over tube
8. Engine coolant cross-over tube-to-radiator vent hose
9. Radiator vent-to-surge tank hose
10. Radiator filler cap
11. Inlet thermostat housing-to-radiator inlet hose
12. Inlet thermostat housing
13. Engine coolant manifold connector housing
14. Engine coolant manifold
15. Connector hoses (8)
16. Engine coolant main tube assembly
17. By-pass thermostat housing assembly
18. Engine coolant drain plug valve
19. Engine coolant pump
20. Engine coolant pump-to-oil cooler tube
21. Surge tank-to-engine coolant pump tube/hose assembly
22. By-pass thermostat housing assembly-to-engine coolant main tube assembly tube
23. Radiator-to-aeration detector hose
24. Aeration detector
25. Aeration detector-to-engine coolant main tube assembly hose

COOLING SYSTEM - CONTINUED

7-1. ENGINE COOLING SYSTEMS, PICTORIAL - CONTINUED

ENGINE COOLING SYSTEM (M109A3, EARLIER VERSION)



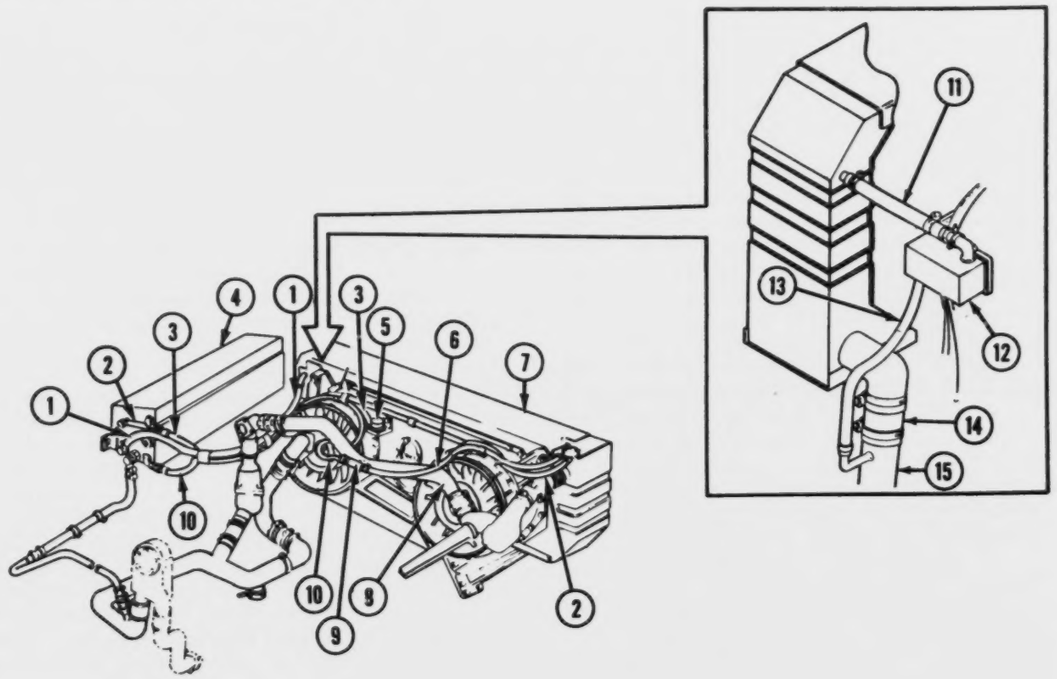
LEGEND

1. Surge tank drain cock
2. Surge tank-to-pressure relief valve hose
3. Radiator-to-surge tank hose
4. Surge tank
5. Engine coolant manifold conector housing
6. Engine coolant manifold connector housing-to-engine coolant crossover tube hose
7. Radiator
8. Radiator fan
9. Surge tank pressure relief valve with block, gasket, and adapter
10. Engine coolant crossover tube plug
11. Engine coolant crossover tube drain cock
12. Engine coolant crossover tube
13. Engine coolant manifold connector housing-to-engine coolant crossover tube hose
14. Radiator filler cap
15. Inlet thermostat housing-to-radiator inlet hose
16. Inlet thermostat housing
17. Engine coolant manifold connector housing
18. Engine coolant manifold
19. Engine coolant crossover tube-to-radiator vent hose
20. Radiator outlet-to-engine coolant lower tube hose
21. Engine coolant lower tube
22. Engine coolant lower tube-to-engine coolant main tube hose
23. Engine coolant drain plug valve
24. Engine coolant main tube
25. Engine coolant pump
26. Engine coolant pump-to-oil cooler tube
27. Engine coolant pump connector hose
28. Surge tank tube-to-engine coolant main tube inlet hose
29. Surge tank tube
30. Surge tank hose
31. Bypass thermostat housing-to-surge tank hose
32. Engine coolant manifold connector housing-to-bypass thermostat housing hose
33. Bypass thermostat upper housing
34. Bypass thermostat lower housing
35. Bypass thermostat lower housing-to-engine coolant main tube inlet hose
36. Radiator-to-aeration detector hose (M109A3)
37. Aeration detector (M109A3)
38. Aeration detector-to-engine coolant lower tube (M109A3)
39. Radiator outlet-to-engine coolant lower tube (M109A3)
40. Engine coolant lower tube (M109A3)

COOLING SYSTEM - CONTINUED

7-1. ENGINE COOLING SYSTEMS, PICTORIAL - CONTINUED

ENGINE COOLING SYSTEM (M109A3, LATER VERSION)



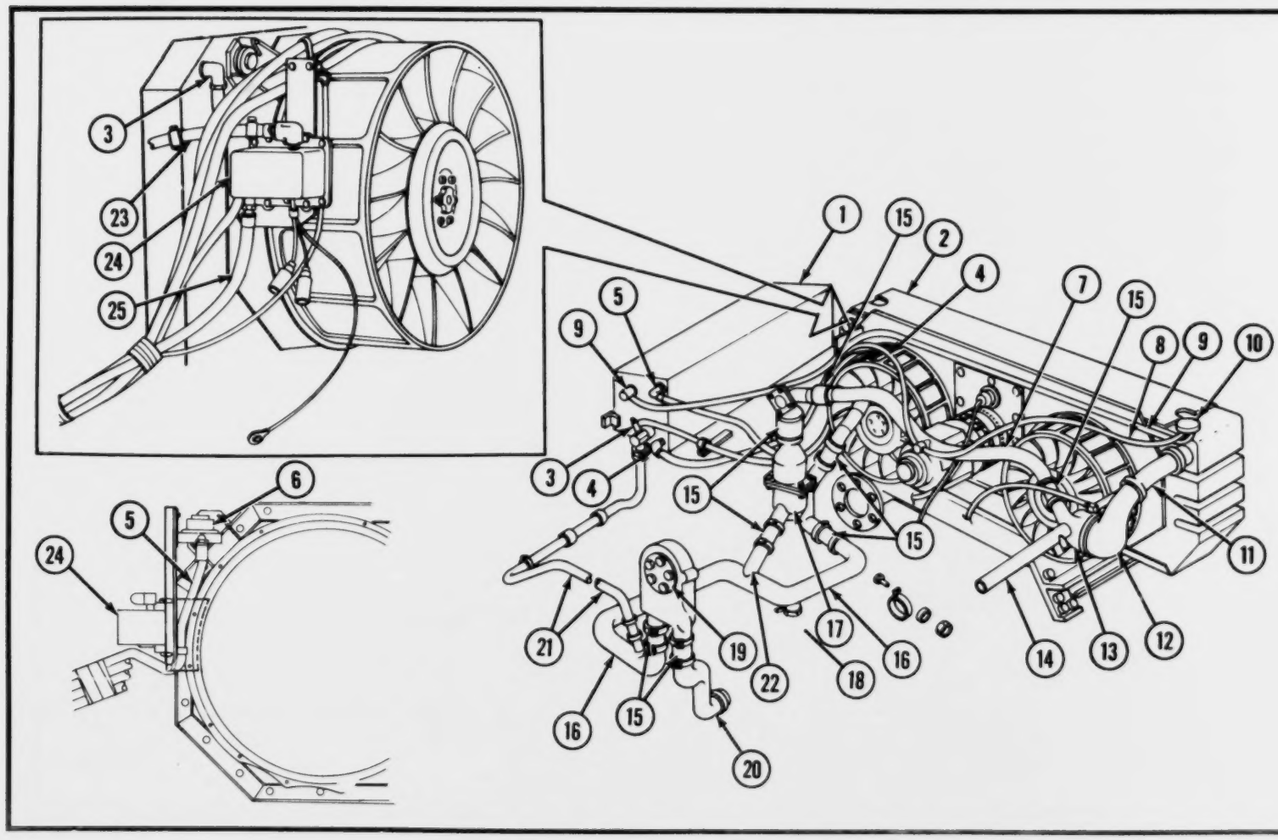
TA472212

LEGEND

1. Surge tank-to-radiator hose
2. Surge tank-to-radiator hose
3. Surge tank-to-pressure relief valve hose
4. Surge tank
5. Surge tank pressure relief valve
6. Crossover tube-to-radiator vent hose
7. Radiator
8. Crossover tube
9. Crossover tube tee
10. Crossover tube-to-surge tank hose
11. Radiator-to-aeration detector hose (M109A3)
12. Aeration detector (M109A3)
13. Aeration detector-to-engine coolant lower tube (M109A3)
14. Radiator outlet-to-engine coolant lower tube hose (M109A3)
15. Engine coolant lower tube (M109A3)

COOLING SYSTEM - CONTINUED

7-1. ENGINE COOLING SYSTEMS, PICTORIAL - M109A4



LEGEND

1. Surge tank
2. Radiator
3. Radiator-to-surge tank hose
4. Engine coolant cross-over tube-to-surge tank hose
5. Surge tank-to-pressure relief valve hose
6. Pressure relief valve assembly
7. Engine coolant cross-over
8. Engine coolant cross-over tube-to-radiator vent hose
9. Radiator vent-to-surge tank hose
10. Radiator filler cap
11. Inlet thermostat housing-to-radiator inlet hose
12. Inlet thermostat housing
13. Engine coolant manifold connector housing
14. Engine coolant manifold
15. Connector hoses (8)
16. Engine coolant main tube assembly
17. By-pass thermostat housing assembly
18. Enigne coolant drain plug
19. Engine coolant pump
20. Engine coolant pump-to-oil cooler tube
21. Surge tank-to-engine coolant pump tube/hose assembly
22. By-pass thermostat housing assembly-to-engine coolant main tube assembly tube
23. Radiator-to-aeration detector hose
24. Aeration detector
25. Aeration detector-to-engine coolant main tube assembly hose

COOLING SYSTEM - CONTINUED

7-2. ENGINE COOLANT TUBES, MAIN

This task covers:

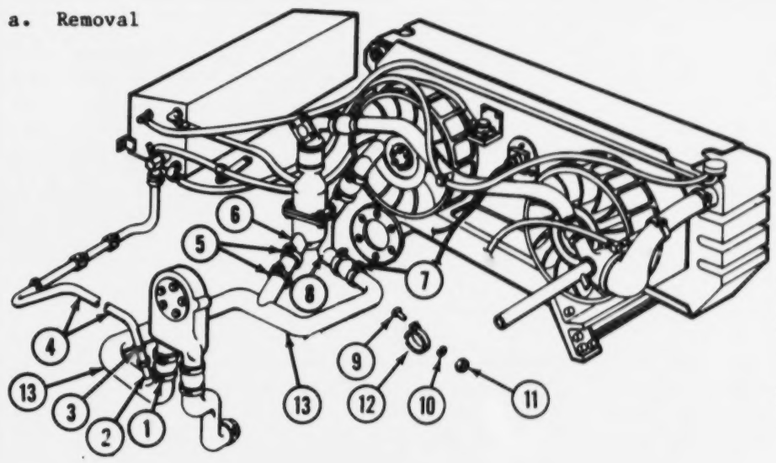
a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Adhesive (Item 6, App. C)

Tools
Automotive Maintenance
Common No. 2 Tool Kit
SC 4910-95-CL-A72

a. Removal



1 Remove powerplant (ref. p. 4-1).

WARNING

To avoid burns, insure engine and coolant have cooled to permit safe removal of components.

2 Drain coolant system (ref. TM 9-2350-311-10).

3 Loosen hose clamp (1) on main inlet hose (2).

TA472213

4 Loosen hose clamp (3) on surge tank tube-to-engine coolant main tube inlet hose (4) and remove hose.

5 Loosen clamp (5) on lower end of bypass thermostat lower housing-to-engine coolant main tube inlet hose (6).

6 Loosen clamp (7) at radiator lower tube assembly (8).

7 Remove screw (9), lockwasher (10), nut (11) and clamp (12) from main coolant tube (13).

8 Remove main coolant tube (10), pulling from connectors at (1), (5), (7) and (12).

b. Installation

NOTE

- Use adhesive (Item 6, App. C) at connectors between hoses and mating tubes or castings.
- Tighten all hose clamps, run engine minimum of 5 minutes and check for leaks (torque clamps to 40 to 60 lb-in (4.5 to 6.8 Nm)).
- Hoses must cover unpainted areas of tubes and fittings or be positioned evenly between red bands on tubes and housings.

Install in reverse order of removal.

COOLING SYSTEM - CONTINUED

7-3. ENGINE COOLANT TUBES, LOWER

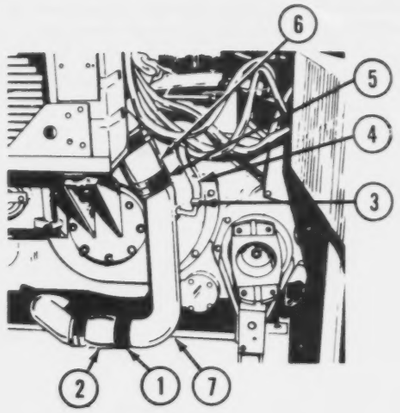
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Adhesive (Item 6, App. C)

a. Removal



1 Remove powerplant (ref. p. 4-1).

2 Loosen two clamps (1) on engine coolant lower tube-to-engine coolant main hose (2).

NOTE

Follow step 3 for M109A3 vehicles only.

3 Loosen clamp (3) on aeration detector hose (4) and remove hose from tube.

4 Loosen two clamps (5) on radiator outlet-to-engine coolant lower tube hose (6).

5 Remove engine coolant lower tube (7).

TA472214

b. Installation

NOTE

- Use adhesive (Item 6, App. C) at connectors between hoses and mating tubes or castings.
- Tighten all hose clamps, run engine minimum of 5 minutes and check for leaks (torque clamps to 40 to 60 lb-in (4.5 to 6.8 Nm)).
- Hoses must cover unpainted areas of tubes and fittings or be positioned evenly between red bands on tubes and housings.

1 Install in reverse order of removal.

2 Apply adhesive (Item 6, App. C) to hose ends when installing.

7-4. SURGE TANK AND PRESSURE RELIEF VALVE

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Gasket
Adhesive (Item 6, App. C)

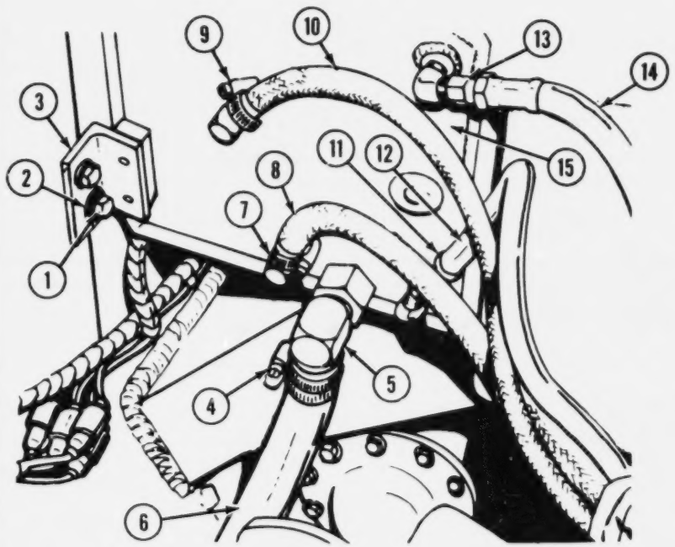
a. Removal

1 To remove surge tank, remove right transmission door and grille support plate (ref. p. 4-11).

COOLING SYSTEM - CONTINUED

7-4. SURGE TANK AND PRESSURE RELIEF VALVE - CONTINUED

a. Removal - Continued



WARNING

To avoid burns, insure engine and coolant have cooled sufficiently to permit safe removal of components.

2 Remove two screws (1), two lockwashers (2) and retainer (3).

NOTE

Illustrations on pages 7-14 and 7-14.1 are provided as guides.

3 Drain coolant system (ref. TM 9-2350-311-10).

4 Loosen two clamps (4) at elbow (5).

5 Loosen three clamps (7), (9) and (11).

6 Unscrew nut (13).

7 Remove five hoses (6), (8), (10), (12) and (14) from surge tank (15).

8 Lift surge tank (15) up and out.

NOTE

The location of the pressure relief valve differs between M109A2/M109A3 and M109A4 vehicles.

9 To remove pressure relief valve, unscrew nut (16) and remove hose (17) and elbow (17.1) from lower end of relief valve (18).

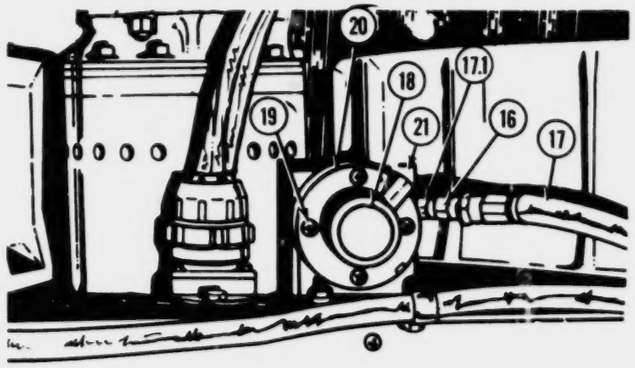
TA472215

10 Remove four screws (19), relief valve (18), and gasket (20) from block (21). Discard gasket.

b. Installation

NOTE

M109A2/M109A3 pictured.



NOTE

Use adhesive (Item 6, App. C) at hose and tube and casting interface when installing surge tank.

1 To install pressure relief valve, replace gasket (20), and install relief valve (18) and four screws (19) onto block (21).

2 Install elbow (17.1), hose (17) and screw on nut (16) at lower end of relief valve (18).

3 Place surge tank (15) back into position.

4 Install five hoses (6), (8), (10), (12) and (14) onto surge tank.

5 Screw nut (13) back on.

6 Tighten three clamps (7), (9), and (11).

7 Tighten two clamps (4) at elbow (5).

8 Install retainer (3), two lockwashers (2) and two screws (1).

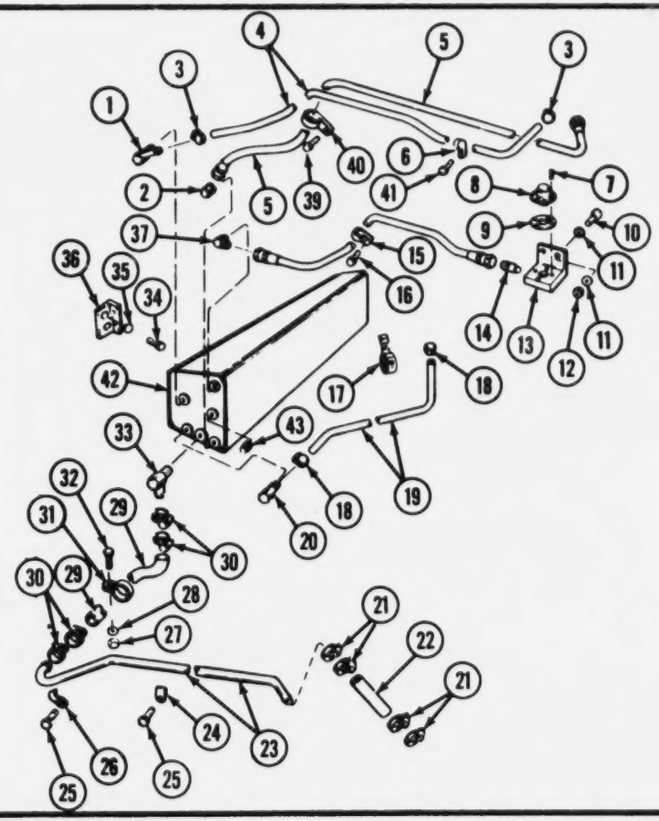
9 Refill coolant system (ref. TM 9-2350-311-10).

10 Install right door and grille support plate (ref. p. 4-13 and 4-12).

TA472216

COOLING SYSTEM - CONTINUED

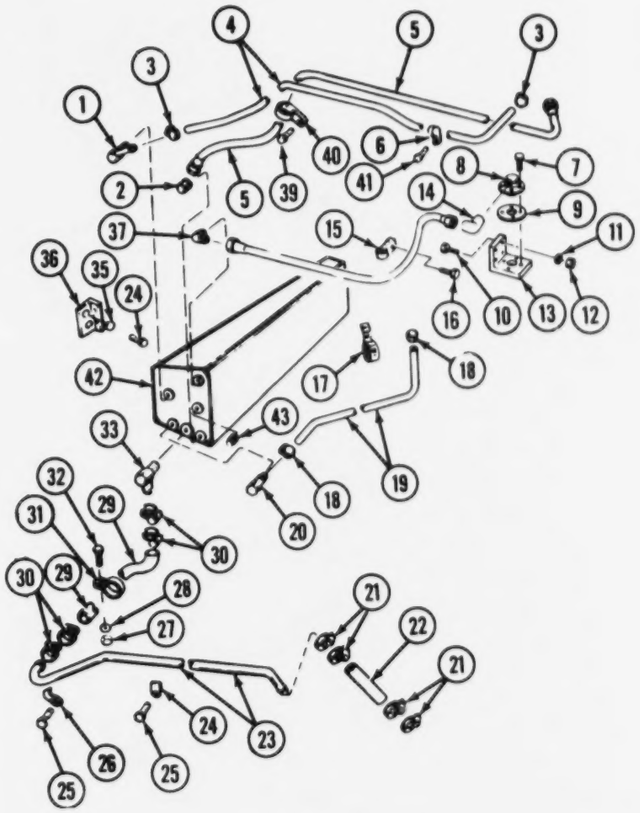
7-4. SURGE TANK AND PRESSURE RELIEF VALVE - CONTINUED



LEGEND (M109A2/M109A3)

1. Elbow
2. Elbow
3. Clamp (2)
4. Hose (radiator vent)
5. Hose (bypass tube)
6. Clamp
7. Screw (4)
8. Pressure relief
9. Gasket
10. Screw (2)
11. Flatwasher (4)
12. Nut (2)
13. Block
14. Adapter
15. Clamp
16. Screw
17. Tape
18. Clamp (2)
19. Hose (radiator)
20. Elbow
21. Clamp (4)
22. Hose
23. Tube
24. Retainer
25. Screw (2)
26. Retainer
27. Nut (2)
28. Flatwasher (2)
29. Hose (main tube)
30. Clamp (2)
31. Clamp (2)
32. Screw (2)
33. Elbow
34. Screw (2)
35. Flatwasher (2)
36. Retainer
37. Elbow
38. Hose (relief valve)
39. Screw
40. Clamp
41. Screw
42. Surge tank
43. Plug

TA472217



LEGEND (M109A4)

1. Elbow
2. Elbow
3. Clamp (2)
4. Hose (radiator vent)
5. Hose (bypass tube)
6. Clamp
7. Screw (4)
8. Pressure relief
9. Gasket
10. Screw (2)
11. Flatwasher (2)
12. Nut (2)
13. Block
14. Elbow
15. Clamp
16. Screw
17. Tape (2 places)
18. Clamp (2)
19. Hose (radiator)
20. Elbow
21. Clamp (4)
22. Hose
23. Tube
24. Retainer
25. Screw (2)
26. Retainer
27. Nut (2)
28. Flatwasher (2)
29. Hose (main tube)
30. Clamp (2)
31. Clamp (2)
32. Screw (2)
33. Elbow
34. Screw (2)
35. Flatwasher (2)
36. Retainer
37. Elbow
38. Hose (relief valve)
39. Screw
40. Clamp
41. Screw
42. Surge tank
43. Plug

7-5. RADIATOR AND SHROUD

This task covers:

a. Removal b. Installation c. Cleaning

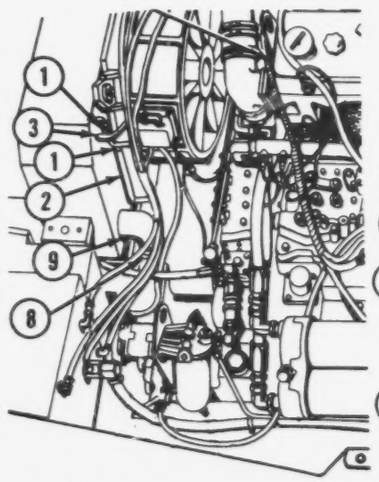
INITIAL SET-UP

Special Tools	Materials/Parts	Personnel Required	Tools
Radiator cleaning tool (Item 36, App. B)	Tape Adhesive (Item 5, App. C) Sealant (Item 46, App C) Detergent (Item 66, App.C)	2	Automotive Maintenance Common No. 2 Tool Kit SC 4910-95-CL-A72

a. Removal

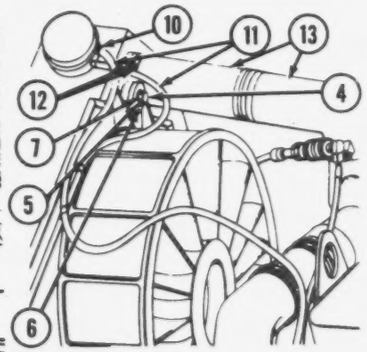
NOTE

Illustration on page 7-17 is provided as a guide.



NOTE

M109A2/M109A3 Pictured



1 To remove radiator, drain coolant from radiator (ref. TM 9-2350-311-10).

2 Loosen two clamps (1) and remove surge-tank-to-radiator hose (2) and radiator-to-aeration-detector hose (3).

3 Remove two screws (4), two lockwashers (5), two flatwashers (6) and two resilient mounts (7).

4 Loosen clamps (8) from radiator outlet tube (9).

5 Loosen two vent hose clamps (10) and remove two radiator vent hoses (11).

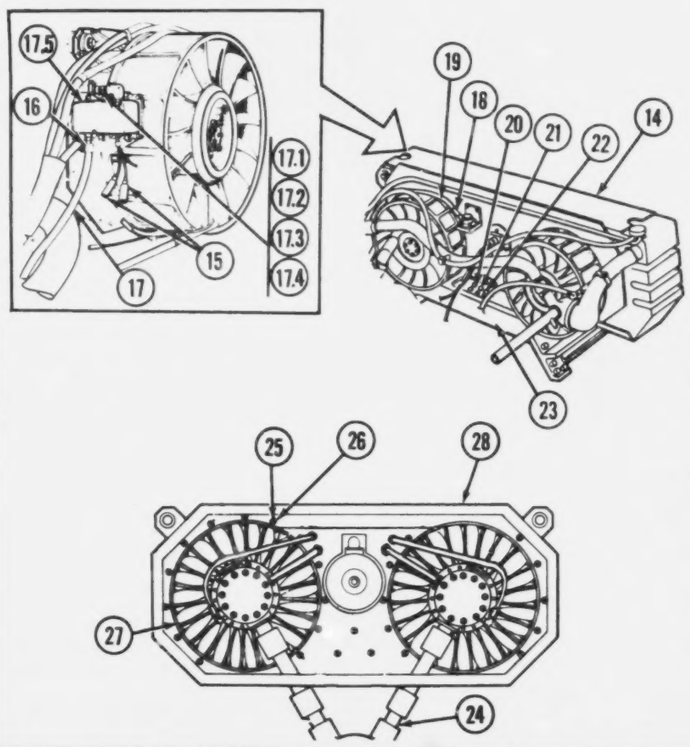
6 Loosen two inlet hose clamps (12) and pull radiator inlet tube (13) free from radiator.

TA472218

COOLING SYSTEM - CONTINUED

7-5. RADIATOR AND SHROUD - CONTINUED

a. Removal - Continued



CAUTION

Radiator weighs 88 lbs/39.9 Kg. Two persons are needed during removal and installation.

7 Lift radiator (14) up and away from shroud.

7.1 Remove alternator (ref. p. 8-5 or p. 8-6.1).

NOTE

Proceed to step 15 for M109A4's

8 Disconnect two electrical connectors (15).

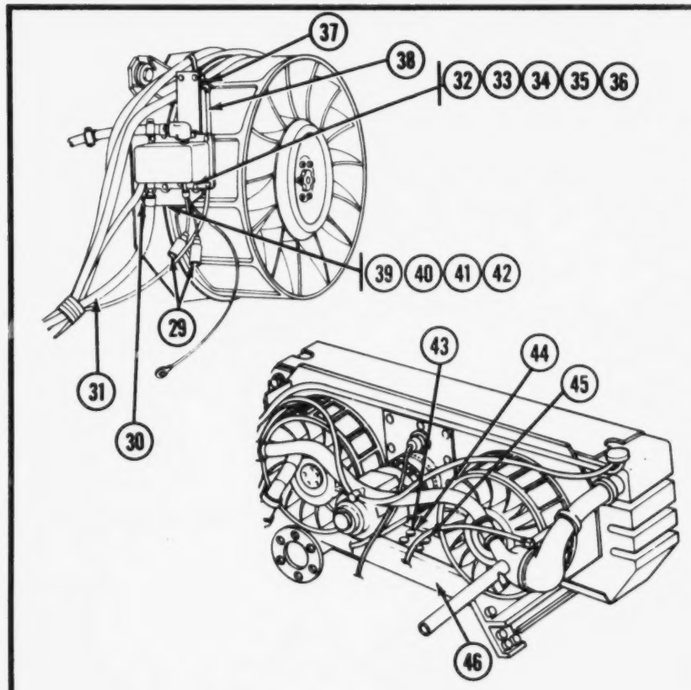
9 Loosen clamp (16) and remove aeration detector-to-engine coolant main tube assembly hose (17).

9.1 Remove two screws (17.1), two lockwashers (17.2), two washers (17.3) and aeration detector bracket (17.4) with detector (17.5).

10 Loosen clamp (18) and remove surge tank to pressure relief valve hose (19).

11 Remove eight screws (20), eight flatwashers (21) and eight lockwashers (22) from bracket (23).

TA472219



12 Depress fan universals (24), lift shroud up to permit removal of universals, then lift shroud away from engine to clear alternator.

13 Remove four screws (25) and clamps (26), removing retainers for radiator vent hoses.

14 Remove shroud (27) and eight seals (28).

15 Inspect oil level in fans (ref. LO-9-2350-311-12)

NOTE

Steps 15 through 22 apply only to M109A4 vehicles.

16 Disconnect two electrical connectors (29).

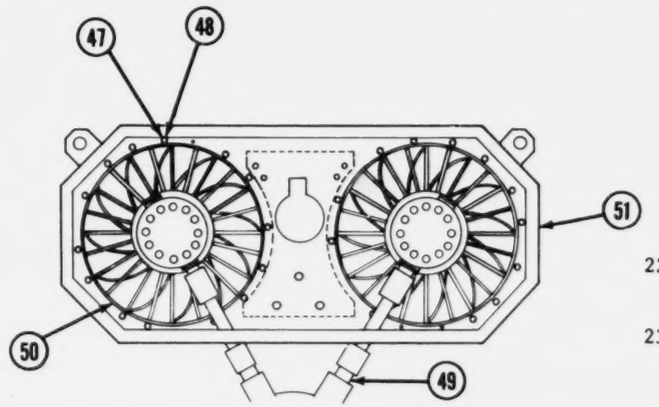
17 Loosen clamp (30) and remove aeration detector-to-engine coolant main tube assembly hose (31).

18 Remove nut (32), lockwasher (33), screw (34), washer (35) and clamp (36).

19 Loosen fitting (37) and disconnect surge tank to pressure relief valve hose (38).

20 Remove two screws (39), two lockwashers (40), two washers (41) and bracket (42) with aeration detector and relief valve installed.

21 Remove eight screws (43), eight flatwashers (44) and eight lockwashers (45) from bracket (46).

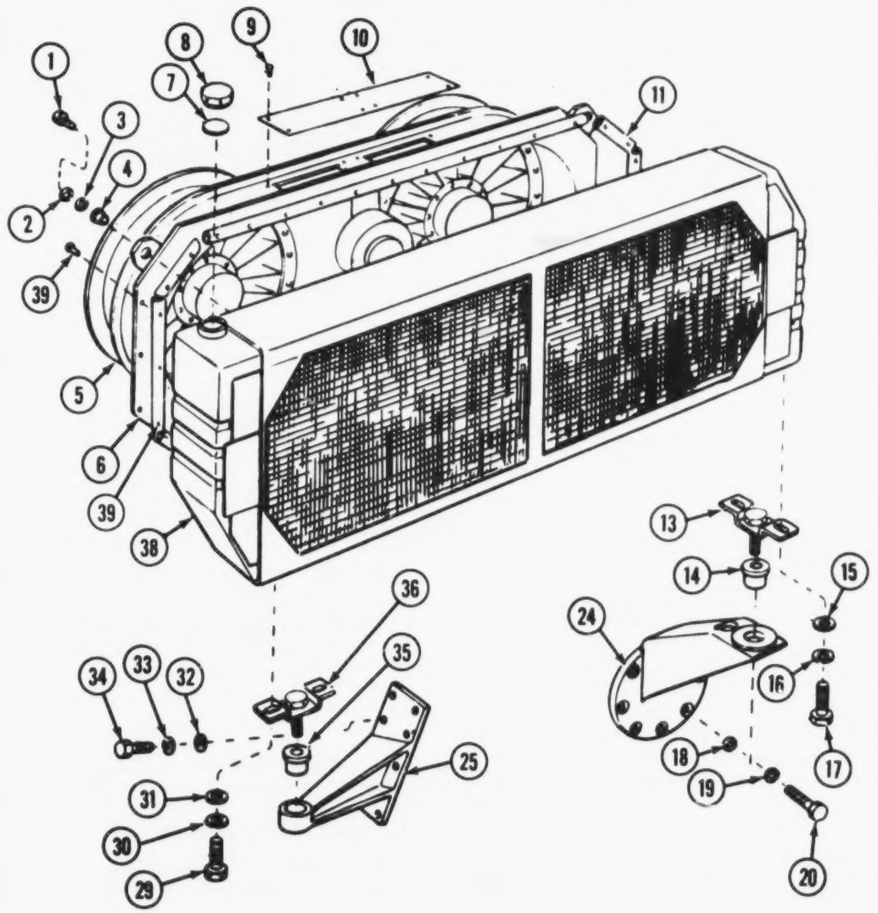


22 Remove three screws(47) and clamps (48), removing retainers for radiator vent hoses.

23 Depress fan universals (49), lift shroud up to permit removal of universals, then lift shroud away from engine to clear alternator.

24 Remove shroud (50) and eight seals (51) with fans and mounting bracket attached.

RADIATOR AND SHROUD



LEGEND

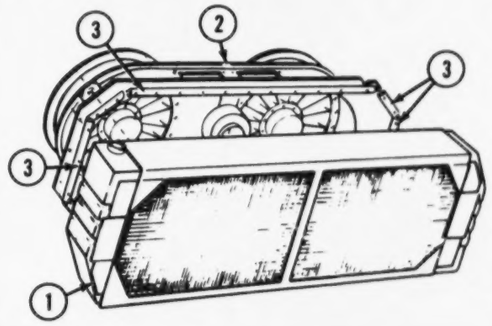
1. Bolt (2)
2. Lockwasher (2)
3. Flatwasher (2)
4. Resilient mount (2)
5. Shroud
6. Seal w/strip (2)
7. Gasket
8. Cap
9. Screw (8)
10. Access cover
11. Seal (2) w/strip (6)
12. Deleted
13. Bracket
14. Mount
15. Flatwasher (2)
16. Lockwasher (2)
17. Screw (2)
18. Flatwasher (8)
19. Lockwasher (8)
20. Screw (8)
21. Deleted
22. Deleted
23. Deleted
24. Deleted
25. Mounting bracket
26. Deleted
27. Deleted
28. Deleted
29. Screw (2)
30. Lockwasher (2)
31. Flatwasher (2)
32. Flatwasher (9)
33. Lockwasher (9)
34. Screw (9)
35. Mount (9)
36. Bracket
37. Deleted
38. Radiator
39. Rivet (36)

TA472220

COOLING SYSTEM - CONTINUED

7-5. RADIATOR AND SHROUD - CONTINUED

b. Installation



1 To install shroud (2), reverse order of removal.

2 Apply sealant to aeration detector bracket screws (item 46, App. C) before installation.

3 Apply adhesive (Item 5, App. C) to seal (3).

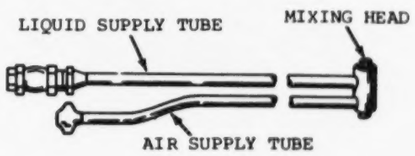
4 Tape seal at eight joints temporarily to allow adhesive to dry.

5 To install radiator (1), reverse order of removal.

6 Torque nuts to 40 ± 5 lb-ft (54 ± 6.7 Nm).

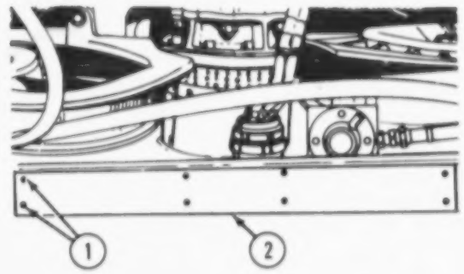
7 Apply adhesive (Item 5, App. C) at connection of all hose and tube mating surfaces.

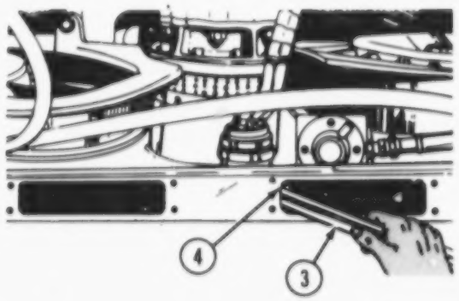
c. Cleaning



The radiator cleaning tool is designed to remove deposits of sand, oil, clay, and other debris from the radiator cooling fins while installed in the vehicle. The cleaning agent may be a water solution of detergent and water, or nontoxic, nonflammable solvent and water. Mix one part of detergent or solvent to approximately five parts of water. A solution of detergent and water is recommended.

TA472221





1 Remove eight screws (1) and radiator shroud cover (2).

2 Open hull drains (ref. TM 9-2350-311-10).

3 Cover all exposed openings of the engine.

4 Connect radiator cleaning tool (3) to air supply and insert hose in container of solution.

5 Insert cleaning tool through shroud cover opening (4). Saturate front and back of radiator with solution. Soak for approximately 10 minutes.

6 Remove heavy deposits from face of radiator by brushing with medium stiff brush that will not damage the fins.

7 Blast radiator exterior with air/liquid mixture, hold head of tool approximately 1/2 in (12.7mm) from face of radiator. Alternate from back to front until a good flow of liquid over the radiator fins is observed over entire area.

8 Wash engine parts and exterior of radiator with clean water. Remove hose from container and use air to complete the task.

9 Uncover engine openings. Install radiator shroud cover (2) with eight screws (1). Close hull drains.

NOTE

If overheating still occurs, notify direct support maintenance.

TA472222

COOLING SYSTEM - CONTINUED

7-6. INLET THERMOSTAT AND HOUSING ASSEMBLY

This task covers:

a. Removal b. Installation

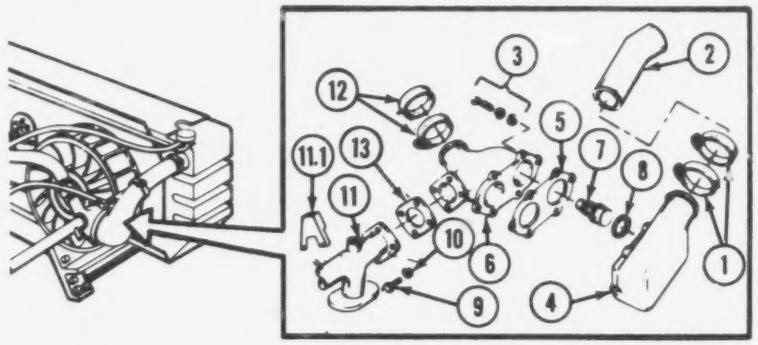
INITIAL SET-UP

Special Tools
Installer and handle
(Item 37 & 38, App. B.)

Materials/Parts
Thermostats (2)
Gaskets (2)
Seals (2)
Adhesive (Item 5, App. C)

a. Removal

NOTE
Protective cover is used only on M109A4's.



WARNING

Insure engine and coolant systems are cool enough to permit safe handling.

1 Drain coolant (ref. TM 9-2350-311-10).

2 Loosen two clamps (1).

3 Remove housing-to-radiator tube (2).

3.1 Remove six screws, six lockwashers, six washers (3).

4 Remove inlet housing (4) and gasket (5) from manifold coolant connector (6). Discard gasket.

TA472223

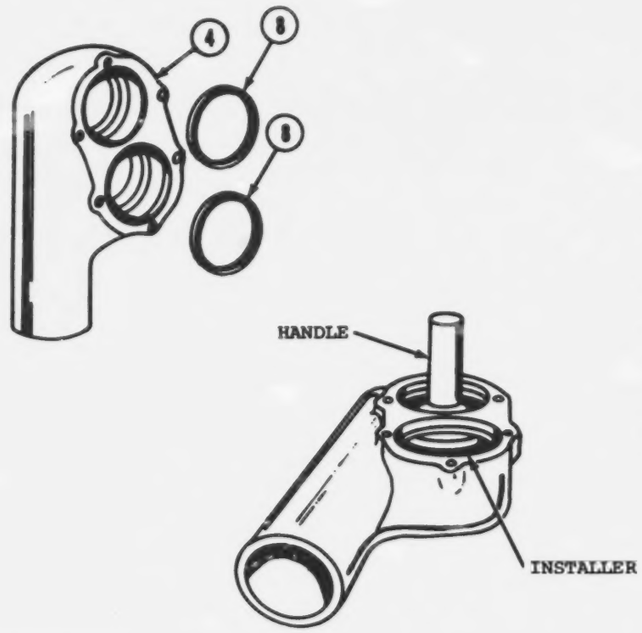
5 Remove two thermostats (7) and two seals (8) and pull outward. Discard thermostats and seals.

6 Remove four screws (9) and four lockwashers (10) at engine coolant manifold (11). Remove protective cover (11.1) if present.

7 Loosen two clamps (12).

8 Remove manifold connector (6) and gasket (13). Discard gasket.

b. Installation



1 To install inlet thermostat, install two seals (8) into inlet housing (4) with leather facing outward using installer and handle.

2 Install housing assembly in reverse order of removal.

3 Replace gaskets (5) and (13).

4 Replace two thermostats (7).

5 Apply adhesive (Item 5, App. C) to hose ends at connection of all hoses and tubes mating surfaces.

6 Refill radiator (ref. TM 9-2350-311-10).

TA472224

COOLING SYSTEM - CONTINUED

7-7. BYPASS THERMOSTAT AND HOUSING ASSEMBLY

This task covers:

a. Removal b. Installation

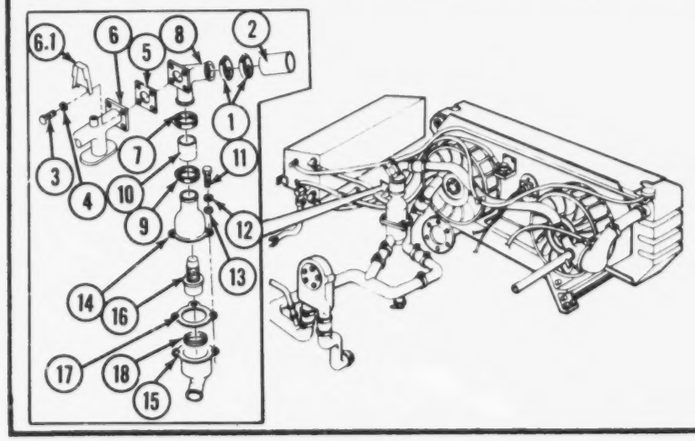
INITIAL SET-UP

Special Tools
Handle and Installer
(Item 37 & 38, App. B)

Materials/Parts
Gaskets (2), Thermostat, Seal,
Adhesive (Item 5, App. C)

NOTE

a. Removal Protective cover is used only on M109A4's



WARNING

Insure engine and coolant system are cool enough to permit safe handling in order to prevent burns.

1 Drain coolant system (ref. TM 9-2350-311-10).

2 Loosen two clamps (1) at crossover tube connector (2).

3 Remove four screws (3), four lockwashers (4) and gasket (5) at engine coolant manifold (6). Discard gasket.

3.1 Protective cover (6.1) must be removed if present.

TA472225

4 Loosen upper clamp (7).

5 Remove manifold connector (8).

6 Loosen lower clamp (9).

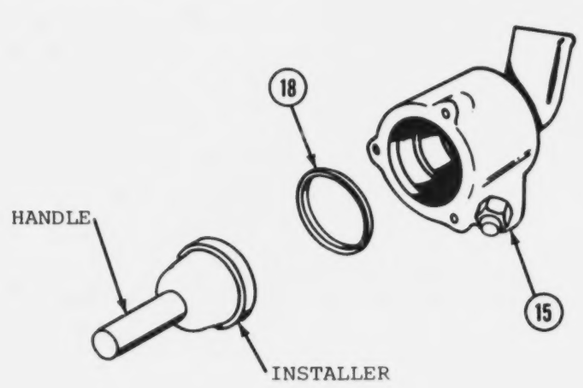
7 Remove coolant hose (10).

8 Remove three screws (11), three flatwashers (12) and three lockwashers (13).

9 Separate upper housing (14) and lower housing (15).

10 Remove thermostat (16), gasket (17), and seal (18) by pulling upward. Discard thermostat, gasket, and seal.

b. Installation



1 Install seal (18) in lower housing (15), using installer and handle.

2 Install housing assembly in reverse order of removal.

3 Replace gaskets (5) and (17).

4 Replace thermostat (16).

5 Apply adhesive (Item 5, App. C) at connections of all hoses and tubes mating surfaces.

6 Refill radiator (ref. TM 9-2350-311-10).

TA472226

COOLING SYSTEM - CONTINUED

7-8. COOLANT PUMP

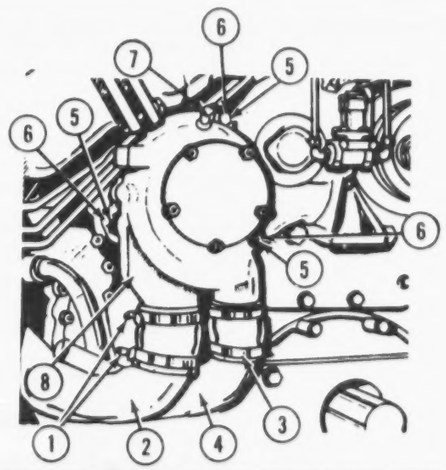
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Gasket
Adhesive (Item 6, App. C)

a. Removal



WARNING

Insure engine and coolant are cool enough to permit safe handling.

1 Remove powerplant (ref. p. 4-1).

2 Drain coolant system (ref. TM 9-2350-311-10).

3 Loosen two clamps (1) on inlet hose (2).

4 Loosen two clamps (3) on outlet hose (4).

5 Remove three screws (5) and three lockwashers (6).

6 Disconnect water manifold tube (7).

TA472227

7 Remove coolant pump (8) and gasket (hidden).

b. Installation

1 Install in reverse order of removal.

2 Apply adhesive to ends of tubes/hoses (Item 6, App C).

COOLING SYSTEM - CONTINUED

7-9. COOLANT HOSES AND TUBES

This task covers:

a. Removal b. Installation

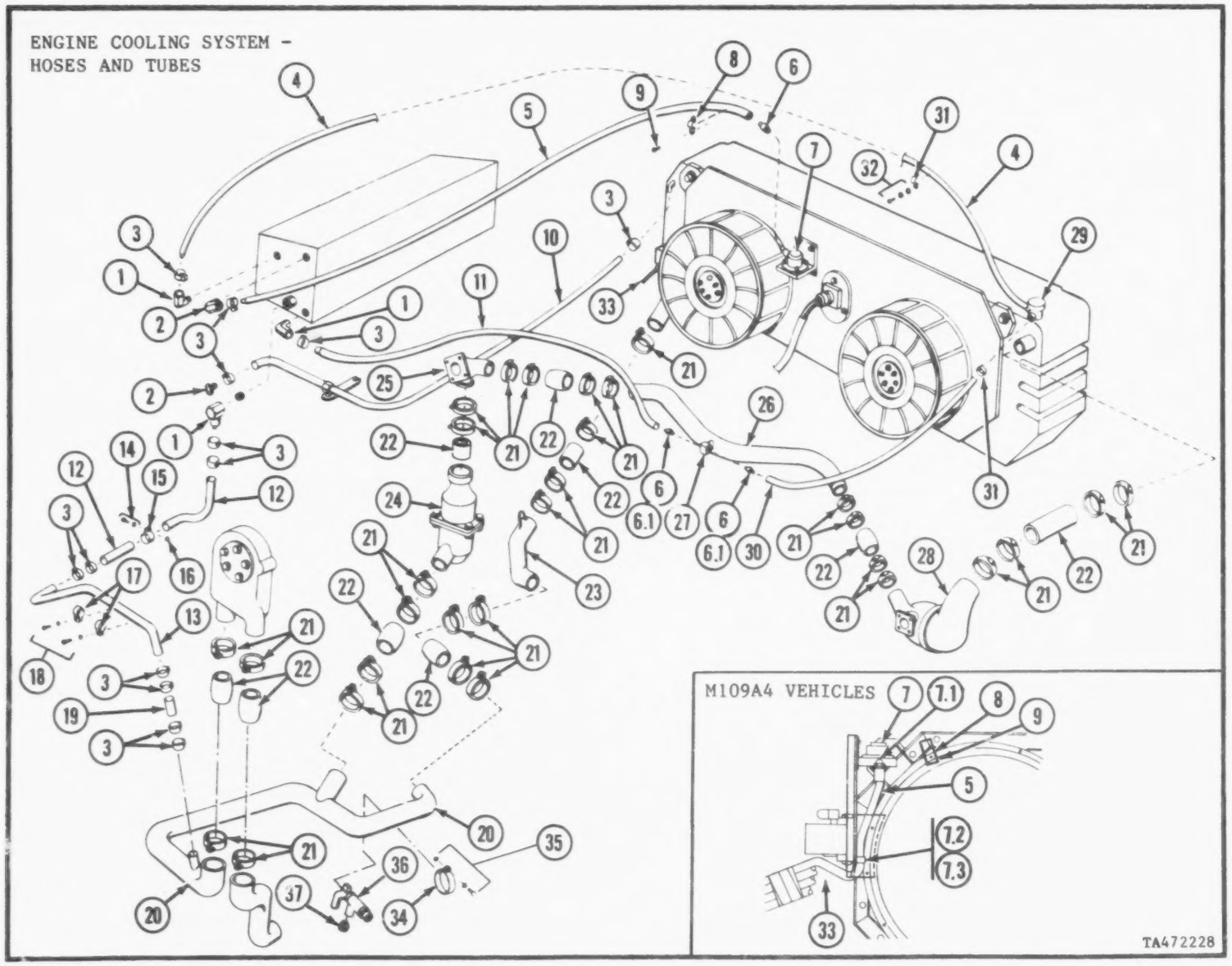
INITIAL SET-UP

Materials/Parts
Gaskets (2), Adhesive (Item 5, App. C)

LEGEND

1. Elbow (3)
2. Elbow (2)
3. Adjustable clamp (13)
4. Hose - surge tank to radiator vent
5. Hose - surge tank to relief valve
6. Adapter (3) (M109A2/M109A3)
6.1 Adapter (2) (M109A4)
7. Pressure relief valve
7.1 Elbow (M109A4)
7.2 Clamp (M109A4)
7.3 Screw, washer, lockwasher and nut (M109A4)
8. Clamp
9. Screw
10. Hose - surge tank to radiator
11. Hose - surge tank to bypass tube
12. Hose - surge tank to tube 12 (to main tube)
13. Tube - hose 12 to hose 19 (to main tube)
14. Screw and lockwasher
15. Clamp
16. Nut
17. Clamp (2)
18. Screw and lockwasher (2)
19. Hose - tube 13 to main tube
20. Main tube
21. Clamp (32)
22. Connector hose (9)
23. Engine coolant lower tube
24. Outlet thermostat housing assembly
25. Engine coolant manifold connector housing
26. Bypass tube
27. Tee connector bypass tube
28. Inlet thermostat housing assembly
29. Radiator filler tube with 2 vents
30. Hose radiator vent to bypass tube
31. Clamp (2)
32. Screw flatwasher and lockwasher (2)
33. Aeration detector assembly tubing
34. Loop clamp
35. Screw , lockwasher and nut
36. Valve
37. Plug

ENGINE COOLING SYSTEM -
HOSES AND TUBES



COOLING SYSTEM - CONTINUED

7-9. COOLANT HOSES AND TUBES - CONTINUED

a. Removal

WARNING

Insure engine and coolant are cool enough to permit safe handling.

Remove coolant hoses and tubes in numerical order of illustration (ref. p. 7-27).

b. Installation

1 Install coolant hoses and tubes in reverse order of removal.

2 Apply adhesive (Item 5, App. C) to ends of tubes and hoses before assembly.

3 Replace gaskets at inlet and outlet thermostat assemblies (28) and (24) if engine coolant manifolds are disconnected.

4 Torque all tube/hose connector clamps to 40 to 60 lb-in (4.5 to 6.8 Nm).

CHAPTER 8

ELECTRICAL SYSTEMS

GENERAL

This chapter illustrates the removal and installation of the powerplant and hull electrical systems and components. Procedures are also included for disassembly and assembly, and checks and adjustments of electrical components, authorized by the MAC for organizational level maintenance.

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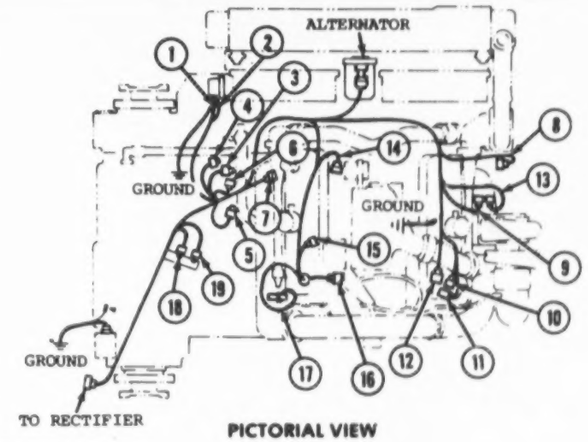
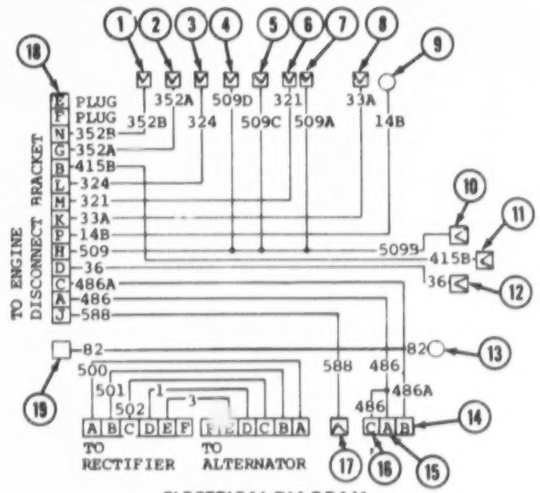


PICTORIAL VIEW



ELECTRICAL DIAGRAM

Connector Number	Electrical Lead To:	Wire No.
1.	Aeration detector	352A
2.	Aeration detector	352B
3.	Transmission oil temperature transmitter	324
4.	Transmission oil high temperature switch	509D
5.	Transmission oil low pressure switch	509C
6.	Transmission oil pressure transmitter	321
7.	Engine coolant high temperature	509A
8.	Engine coolant temperature transmitter	33A
9.	Starter motor solenoid from starter relay	14B
10.	Engine oil low pressure switch	509B
11.	Air cleaner blower motor switch	415
12.	Engine oil pressure transmitter	36
13.	Starter motor solenoid from master relay	82
14.	Flame heater ignition coil	486
15.	Flame heater air pump	486
16.	Flame heater solenoid	486A
17.	Fuel prime pump	588
18.	Master circuit harness	12268102
19.	Starter cable connector	82

TA472229

8-1. ALTERNATOR

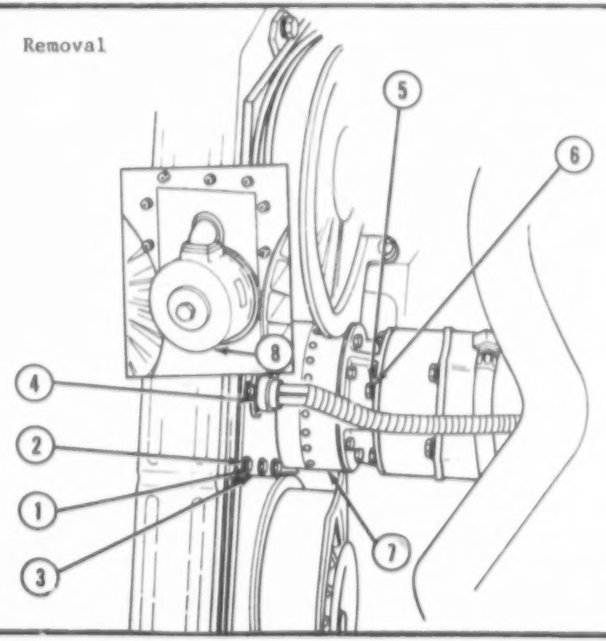
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts	Personnel Required
Gasket	2

a. Removal



1 Disconnect batteries (ref. p. 8-55).

2 Remove coolant radiator (ref. p. 7-15).

3 Remove seven screws (1), seven lockwashers (2) and cover (3) from the radiator shroud.

4 Disconnect alternator-to-rectifier wiring harness (4) at alternator.

5 Remove six mounting nuts (5) and six lockwashers (6).

WARNING

Alternator weighs 85 pounds (38.6 Kg). Use care and grip firmly when removing to avoid serious injury.

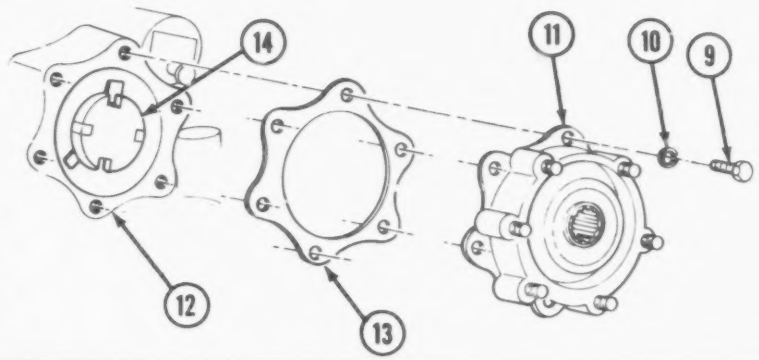
6 Remove alternator (7) and grommet (8).

TA472230

ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-1. ALTERNATOR - CONTINUED

a. Removal - Continued



NOTE

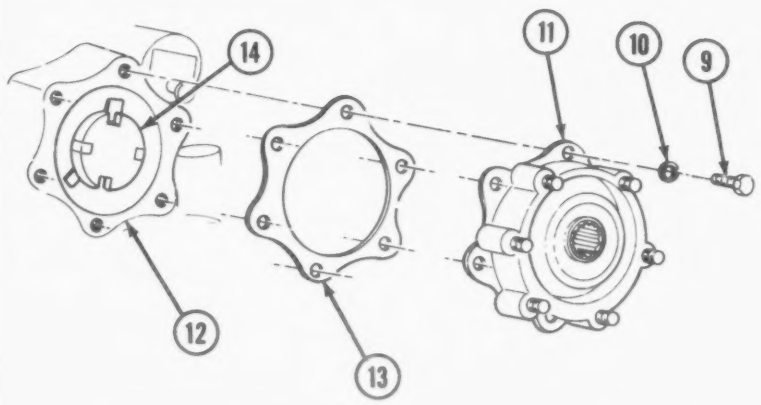
Steps 7 through 9 must be performed each time the alternator is removed.

7 Remove six bolts (9) and six lockwashers (10).

8 Separate accessory drive housing (11) from flywheel housing (12) and remove gasket (13) and drive coupling (14). Discard gasket.

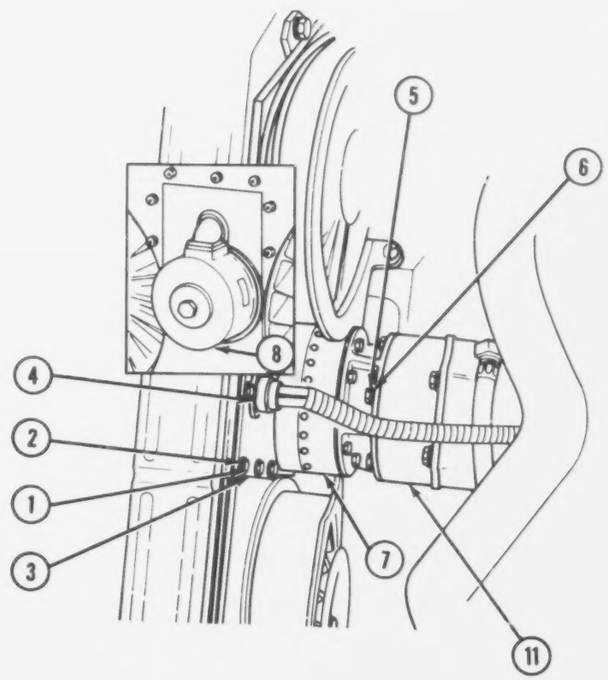
9 Discard drive coupling (14) if cracked, broken or shows signs of disintegration.

b. Installation



1 Install drive coupling (14), gasket (13) and accessory drive housing (11) onto flywheel housing (12).

2 Install six lockwashers (10) and six bolts (9).



WARNING

Alternator weighs 85 pounds (38.6 Kg). Use care and grip firmly when installing to avoid serious injury.

3 Position grommet (8), alternator (7) on accessory drive housing (11).

4 Install six lockwashers (6) and six mounting nuts (5).

5 Connect alternator-to-rectifier wiring harness (4) at alternator.

6 Install cover (3), seven screws (1) and seven lockwashers (2) on the radiator shroud.

7 Install coolant radiator (ref. p. 7-15).

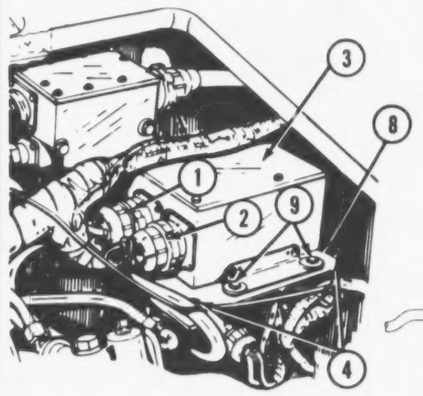
8 Connect batteries (ref. p. 8-55).

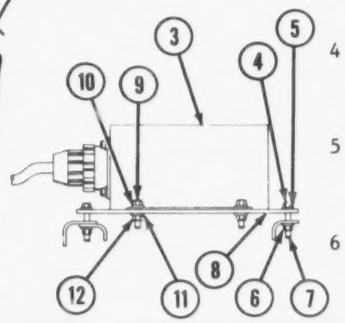
8-2. VOLTAGE REGULATOR

This task covers:

a. Removal b. Installation

a. Removal





1 Disconnect batteries (ref. p. 8-55).

2 Disconnect wiring harness connectors (1) and (2) at voltage regulator (3).

3 Remove four screws (4), four flatwashers (5), four lockwashers (6) and four nuts (7).

4 Slide mount (8) forward far enough to gain access to voltage regulator mounting screws (9).

5 Remove four screws (9), four flatwashers (10), four lockwashers (11) and four nuts (12).

6 Remove voltage regulator (3).

b. Installation

NOTE

A good ground is essential to prevent radio static and to permit starter relay and bilge pump to operate.

Install in reverse order of removal.
Make certain ground lead is firmly attached to regulator mounting screw.

TA472232

ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-3. RECTIFIER

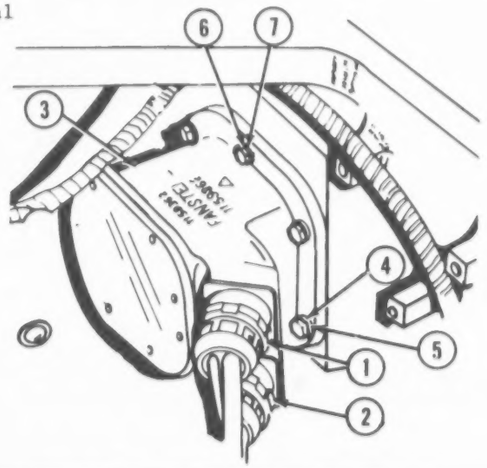
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Packing
Silicone compound (Item 47, App. C)

a. Removal



1 Disconnect batteries (ref. p. 8-55).

2 Disconnect two wiring harness connectors (1) and (2) at rectifier (3).

3 Remove four screws (4) and four flatwashers (5).

4 Remove two brass screws (6) and two lockwashers (7).

5 Remove rectifier (3).

6 Remove packing from rectifier base. Scrape base groove clean.

TA472233

b. Installation

1 Remove paint from rectifier mounting base and from mating surface of hull, if required. Make certain surfaces are clean.

2 Coat mounting base of rectifer and mating hull surface with silicone compound.

3 Install packing in rectifier mounting base groove. Use silicone compound (Item 47, App. C) to hold packing.

4 Install rectifier (3), two brass screws (6) and two lockwashers (7). Torque screws to 16 lb-ft (22 Nm).

5 Install four screws (4) and four flatwashers (5). Torque screws to 30 lb ft (41 Nm).

6 Connect wiring harnesses (1) and (2).

7 Connect batteries (ref. p. 8-55).

ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-3.1. RECTIFIER - M109A4

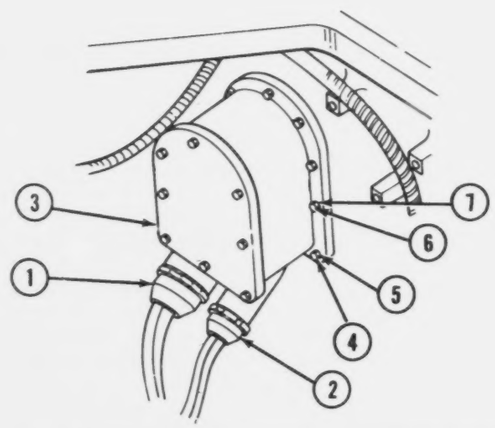
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Silicone heat sink compound (Item 62, App. C)

a. Removal



1 Disconnect batteries (ref. p. 8-55).

2 Disconnect two wiring harness connectors (1) and (2) at rectifier (3).

3 Remove six screws (4) and six flatwashers (5).

4 Remove two brass screws (6) and two lockwashers (7).

5 Remove rectifier (3).

6 Remove packing from rectifier base. Scrape base groove clean.

best copy available

b. Installation

1 Remove paint from rectifier mounting base and from mating surface of hull, if required. Make certain surfaces are clean.

2 Coat mounting base of rectifier and mating hull surface with silicone heat sink compound (Item 62, App C).

3 Install packing in rectifier mounting base groove.

4 Install rectifier (3), two brass screws (6) and two lockwashers (7).

5 Install six screws (4) and six flatwashers (5).

6 Connect wiring harnesses (1) and (2).

7 Connect batteries (ref. p. 8-55).

ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-4. ENGINE COOLANT TEMPERATURE TRANSMITTER AND PROTECTIVE COVER

This task covers:

a. Removal b. Installation

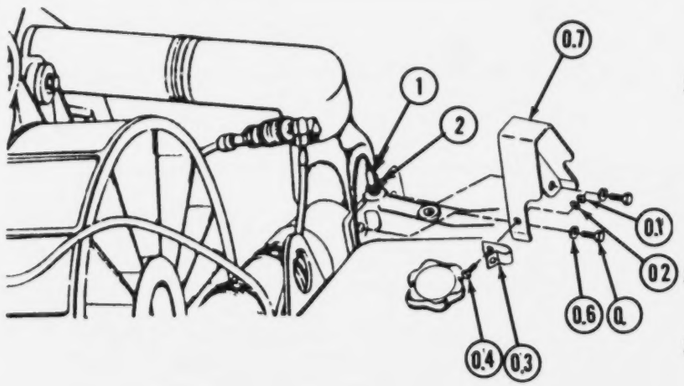
a. Removal

WARNING

Insure engine is cooled. Hot coolant will cause severe burns.

NOTE

- The position of the engine coolant temperature transmitter differs slightly between M109A2/M109A3 and M109A4 vehicles.
- Only M109A4 vehicles have protective covers installed.



1 Open the powerplant air intake door and lock in position (ref. p. 11-21).

NOTE

Cover does not have to be removed for removal of engine coolant temperature transmitter.

1.1 Remove nut (0.1), lockwasher (0.2), clamp (0.3) and screw (0.4).

1.2 Remove two screws (0.5), two lockwashers (0.6) and lift cover (0.7) off.

2 Disconnect electrical connector (1) of wire 33A.

NOTE

Coolant will drain through opening when transmitter is removed. Install replacement transmitter immediately.

3 Unscrew engine coolant temperature transmitter (2) and remove.

b. Installation

Install in reverse order of removal.

8-5. ENGINE COOLANT HIGH TEMPERATURE SWITCH AND PROTECTIVE COVER

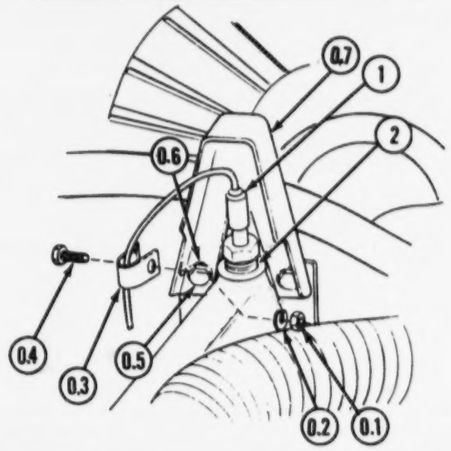
This task covers:

a. Removal b. Installation

a. Removal

WARNING

Insure engine is cooled. Hot coolant will cause severe burns.



NOTE

- The position of the engine coolant temperature switch differs slighty between M109A2/M109A3 and M109A4 vehicles.
- Only M109A4 vehicles have protective covers installed.

1 Open the powerplant air intake door and lock in position (ref. p. 11-21).

NOTE

Cover does not have to be removed for removal of engine coolant temperature switch.

1.1 Remove nut (0.1), lockwasher (0.2), clamp (0.3) and screw (0.4).

1.2 Remove two screws (0.5), two lockwashers (0.6) and lift cover (0.7) off.

2 Disconnect electrical connector (1) of wire 509A.

NOTE

Coolant will drain through opening when transmitter is removed. Install replacement transmitter immediately.

3 Unscrew engine coolant temperature switch (2) and remove.

b. Installation

Install in reverse order of removal.

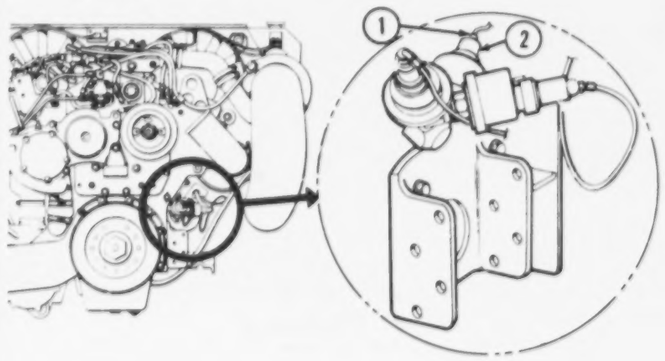
ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-6. ENGINE OIL PRESSURE TRANSMITTER

This task covers:

a. Removal b. Installation

a. Removal



1 Remove engine compartment access door located in driver's compartment (ref. p. 11-20).

2 Disconnect electrical connector (1).

3 Unscrew and remove engine oil pressure transmitter (2) from mount.

b. Installation

Install in reverse order of removal.

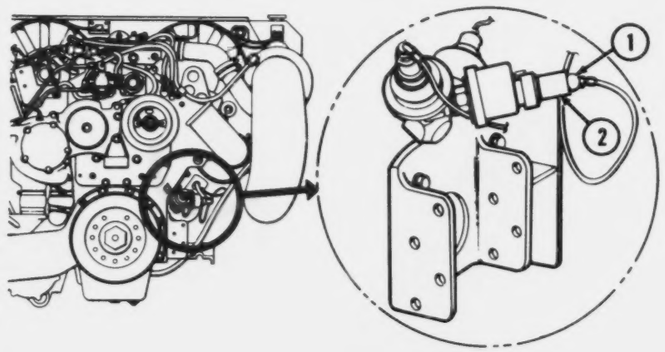
TA472236

8-7. ENGINE OIL LOW PRESSURE SWITCH

This task covers:

a. Removal b. Installation

a. Removal



1 Remove engine compartment access door located in driver's compartment (ref. p. 11-20).

2 Disconnect electrical connector (1).

3 Unscrew and remove engine oil low pressure switch (2) from mount.

b. Installation

Install in reverse order of removal.

TA472237

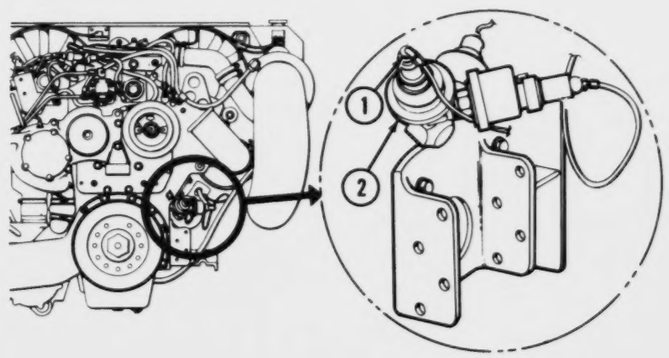
ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-8. AIR CLEANER BLOWER MOTOR SWITCH

This task covers:

a. Removal b. Installation

a. Removal



1 Remove engine compartment access door located in driver's compartment (ref. p. 11-20).

2 Disconnect electrical connector (1).

3 Unscrew and remove air cleaner blower motor switch (2) from mount.

b. Installation

Install in reverse order of removal.

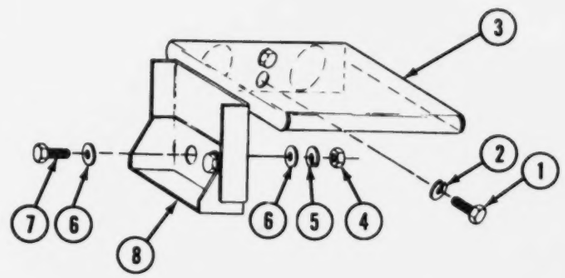
TA472238

8-8.1 TRANSMISSION OIL TEMPERATURE TRANSMITTER ANDTRANSMISSION OIL HIGH TEMPERATURE SWITCH PROTECTIVE COVER - M109A4

This task covers:

a. Removal b. Installation

a. Removal



1 Open right transmission access door.

2 Remove transmission oil temperature transmitter and transmission oil high temperature switch (ref. p. 8-15).

3 Remove two screws (1), two lockwashers (2) and protective cover (3).

4 Disassemble protective cover (3) by removing two nuts (4), two lockwashers (5), four flatwashers (6), two screws (7) and support leg (8).

b. Installation

1 Install in reverse order of removal.

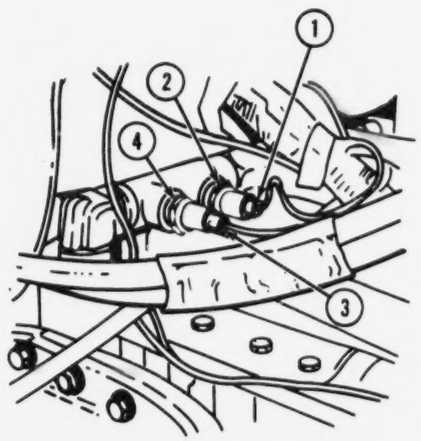
2 Loosen two nuts (4) and adjust support leg (8) to fit against transmission. Tighten two nuts (4).

8-9 TRANSMISSION OIL TEMPERATURE TRANSMITTER AND TRANSMISSION OIL HIGH TEMPERATURE SWITCH

This task covers:

a. Removal b. Installation

a. Removal



NOTE

M109A4 vehicles have manifolds modified to accept a protective cover (ref. p. 8-14.1). This cover does not need to be removed for the following procedure.

1 Open right transmission access door.

2 Disconnect electrical connector (1) of wire 324 at transmitter (2).

3 Unscrew transmission oil temperature transmitter (2) and remove.

4 Disconnect electrical connector of wire 509D (3) at temperature switch (4).

5 Unscrew and remove high temperature switch.

b. Installation

Install in reverse order of removal.

TA472239

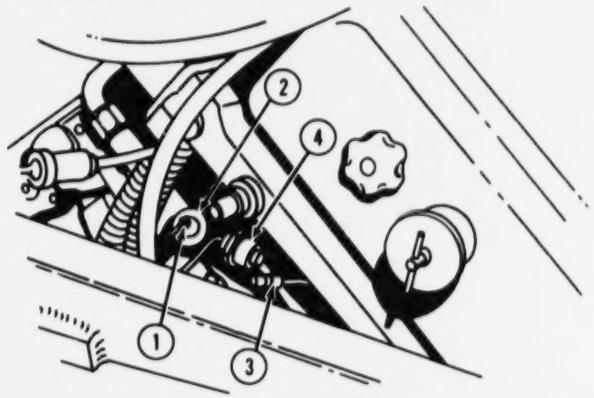
ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-10. TRANSMISSION OIL PRESSURE TRANSMITTER AND TRANSMISSION OIL LOW PRESSURE SWITCH

This task covers

a. Removal b. Installation

a. Removal



1 Open right transmission access door.

2 Disconnect electrical connector (1) of wire 321.

3 Unscrew and disconnect transmission oil pressure transmitter (2).

4 Disconnect electrical connector (3) of wire 509C.

5 Unscrew and remove transmission low oil pressure switch (4).

b. Installation

Install in reverse order of removal.

TA472240

8-11. STARTER MOTOR

This task covers:

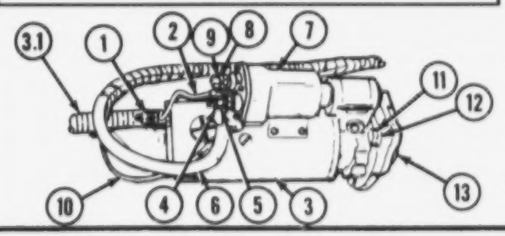
a. Removal b. Installation

INITIAL SET-UP

Material/Parts	Personnel Required
Gasket	2

a. Removal

WARNING
Starter weighs 80 pounds (36.3 kg.). Use care during removal and installation to avoid serious injury.



1 Remove powerplant from vehicle (ref. p. 4-1).

2 Remove nut (1) and ground lead (2) from starter (3). On M109A4 vehicles, ground lead 5A (3.1) shall also be disconnected.

3 Remove nut (4), flatwasher (5) and starter cable (wire 82; M109A2/M109A3/wire 6A; M109A4) (6) at starter solenoid (7).

4 Remove nut (8), flatwasher (9) and solenoid lead (10) at solenoid (7).

5 Remove three screws (11) and three lockwashers (12).

6 Remove starter motor assembly (3) and mounting gasket (13). Discard gasket.

b. Installation

1 Install in reverse order of removal (steps 2 through 6). Replace gasket (13).

2 Operate powerplant while removed from vehicle (ref. p. 4-1).

3 Install powerplant in vehicle (ref. p. 4-1).

TA472241

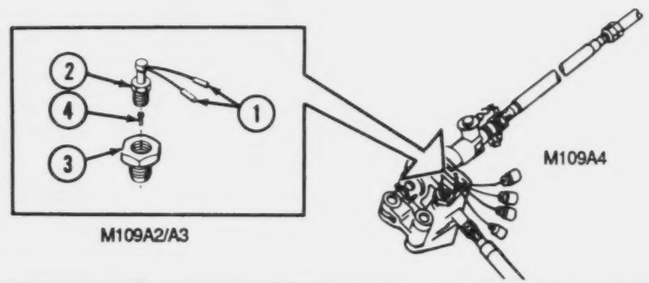
ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-12. NEUTRAL SAFETY SWITCH

This task covers:

a. Removal a.1. Disassembly/Repair a.2. Assembly b. Installation c. Adjustment

a. Removal



NOTE

The following procedure applies to both M109A2/M109A3 and M109A4 vehicles. Proceed only as required.

1 Disconnect two electrical connectors (M109A2/A3) (1) or four electrical connectors (M109A4) (1).

2 Unscrew neutral safety switch (2) counterclockwise to remove from adapter (3). Remove pin (4) along with switch.

a.1. Disassembly/Repair

Disassemble switch leads (ref. p. 2-23)

a.2. Assembly

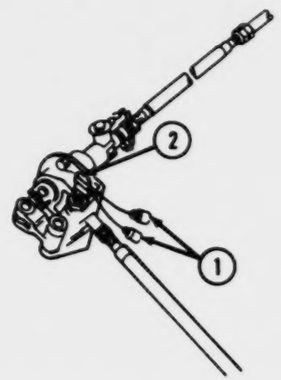
Assemble in reverse order of disassembly.

b. Installation

Install in reverse order of removal.

TA472242

c. Adjustment



NOTE

The following procedure applies only to the M109A2/M109A3 neutral safety switch.

1 Deleted

2 Place shift control lever in gear.

3 If vehicle starts while in gear, turn the switch (2) counterclockwise until a click is heard.

3.1 Place shift control lever in neutral position.

4 If vehicle does not start in neutral, turn switch (2) clockwise. Stop when a click is heard.

5 Deleted.

TA472243

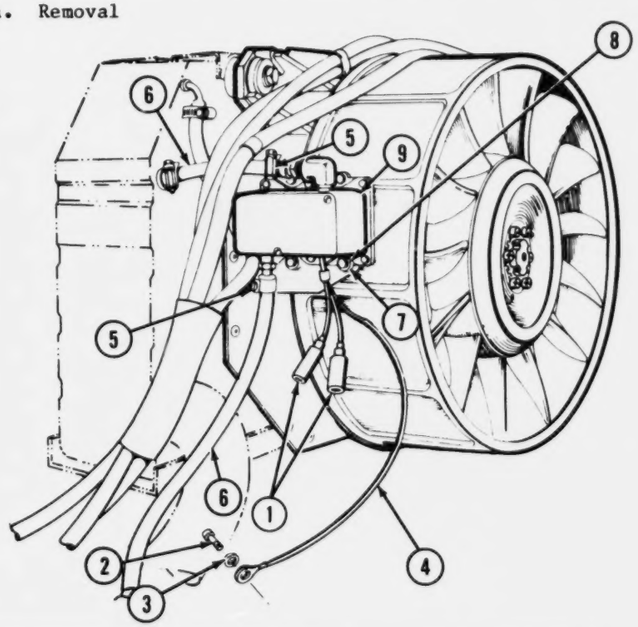
ELECTRICAL SYSTEMS - SECTION I. POWERPLANT ELECTRICAL SYSTEMS - CONTINUED

8-13. AERATION DETECTOR

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Insure engine is cooled. Hot coolant will cause severe burns.

1 Drain radiator (ref. TM 9-2350-311-10).

2 Disconnect two electrical connectors (1) of wires 352A and 352B.

3 Remove screw (2), flatwasher (3) and ground wire (4).

4 Loosen both hose clamps (5).

5 Remove both hoses (6) and plug from radiator and main tube.

TA472244

6 Remove four screws (7) and four lockwashers (8).

7 Remove aeration detector (9).

b. Installation

Install in reverse order of removal.

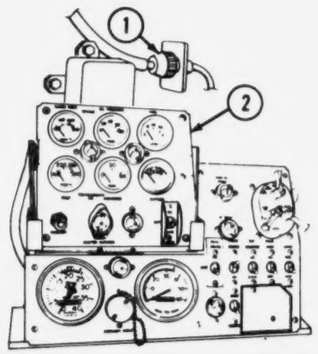
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS

8-14. PORTABLE AND DRIVER'S INSTRUMENT PANELS

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

a. Removal



1 Disconnect batteries (ref. p. 8-55).

2 Disconnect electrical harness/connector (1) at hull bracket.

3 Lift off portable instrument panel (2) from driver's instrument panel bracket.

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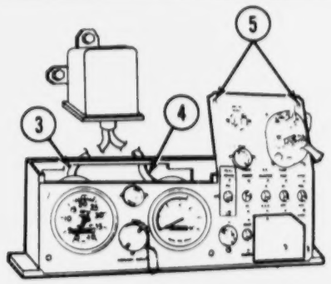
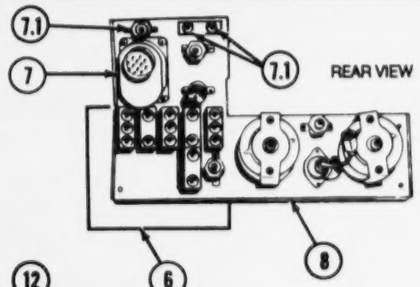


4 Disconnect flexible tachometer cable (3) and flexible speedometer cable (4) at back of instrument housings.

5 Disconnect six stud fasteners (5) by pushing in with a screwdriver and turning counterclockwise.



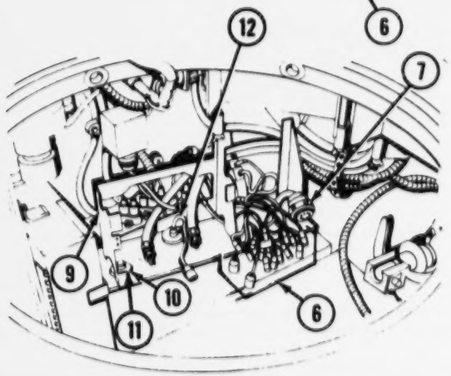
6 Disconnect 20 instrument panel connectors (6) and light switch connector (7) at the back of panel.

6.1 For M109A4 vehicles, disconnect additional three connectors (7.1).

7 Remove driver's instrument panel (8) from mounting support (9).

8 Remove four screws (10), four washers (11) and ground strap (12).

9 Remove mounting support (9).

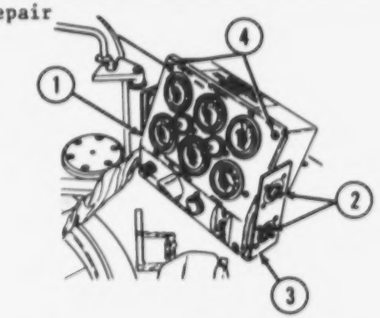


TA472246

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

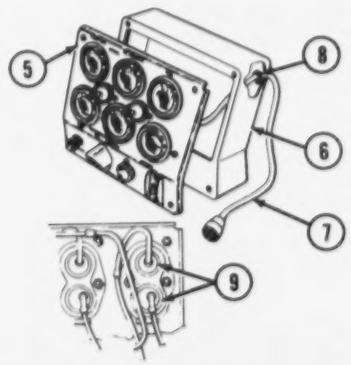
8-14. PORTABLE AND DRIVER'S INSTRUMENT PANELS - CONTINUED

b. Disassembly/Repair



1 Disassemble portable instrument panel (1) by removing four crosspoint screws (2) to separate panel from bracket assembly (3).

2 Disconnect the four stud fasteners (4) by pushing in and turning counterclockwise.



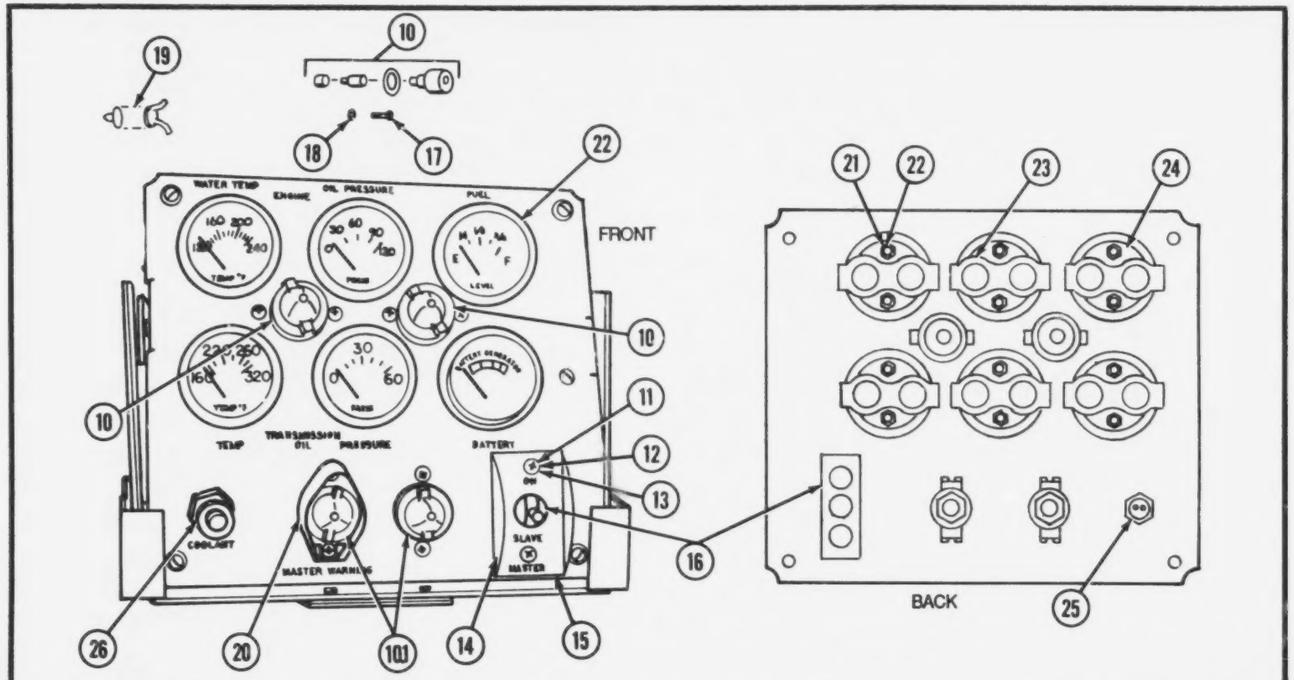
3 Pull panel (5) away from instrument panel cover (6).

4 Slide grommet back on wiring harness (7) to allow for slack to enable disassembly of panel. Remove grommet (8).

5 Disconnect all of the electrical connectors (9) from the back of the portable panel.

6 Remove harness assembly (7) from portable instrument panel cover (6).

TA472247



7 Unscrew and remove two lamp assemblies (lens, packing, lamp and gasket) (10) from the front of the panel.

7.1 Unscrew and remove two LED assemblies (lens, LED and gasket) (10.1) from the front of the panel.

8 Remove two screws (11), two flatwashers (12), two lockwashers (13), switch guard (14), identification plate (15) and master switch (16).

9 Remove eight screws (17) and eight washers (18). Remove the four light brackets (19) and shield light assembly (20).

10 Remove 12 nuts (21), 12 lockwashers (22), six brackets (23) and six indicators (24).

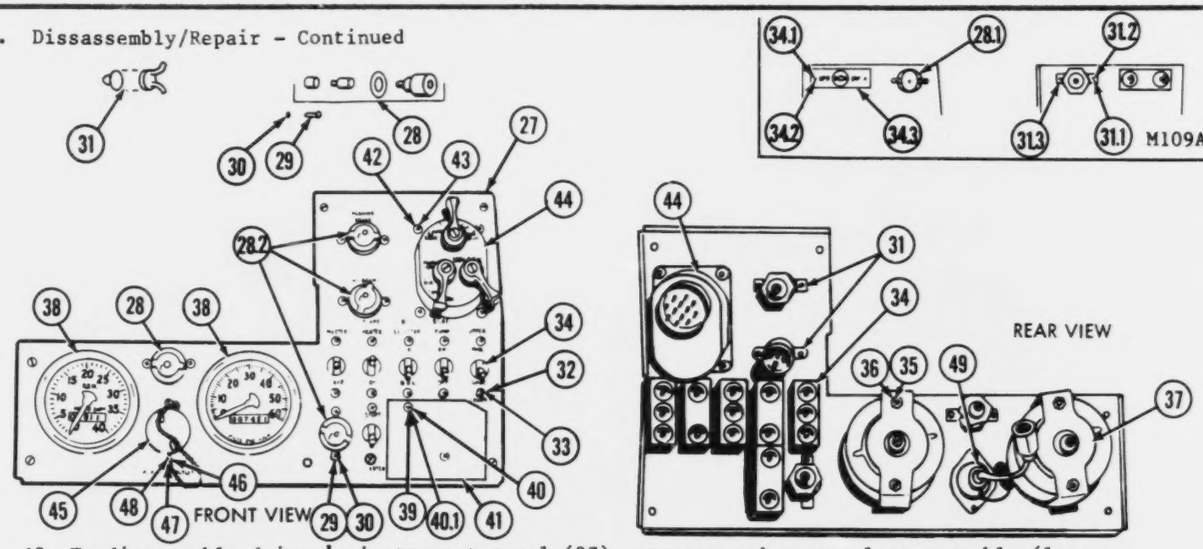
11 Remove hexnut (25) and low coolant indicator LED (26).

TA472248

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-14. PORTABLE AND DRIVER'S INSTRUMENT PANELS - CONTINUED

b. Dissassembly/Repair - Continued



12 To disassemble driver's instrument panel (27), unscrew and remove lamp assembly (lens, packing, lamp and gasket) (28) from panel.

12.1 For M109A4 vehicles, unscrew and remove lamp assembly (lens, packing, lamp and gasket) (28.1) from panel.

12.2 Unscrew and remove three LED assemblies (lens, LED and gasket) (28.2) from panel.

13 Remove eight screws (29), eight washers (30) and four light brackets (31).

13.1 For M109A4 vehicles, remove two screws (31.1), two washers (31.2) and light bracket (31.3).

14 Remove 12 screws (32), 12 flatwashers (33) and six switch assemblies (34).

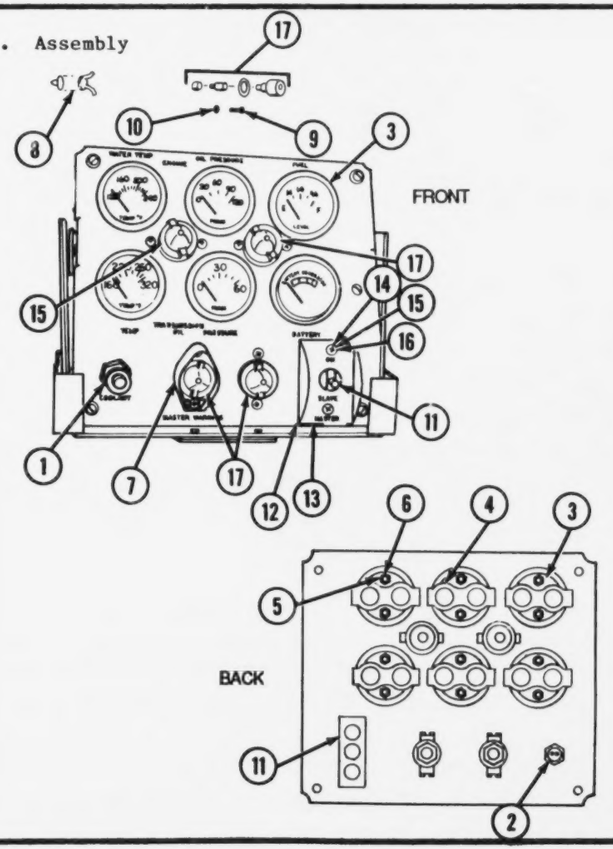
14.1 For M109A4 vehicles, remove two screws (34.1), two flatwashers (34.2) and switch assembly (34.3).

15 Remove four nuts (35), four washers (36), two brackets (37) and two indicators (38).

16 Remove two screws (39), two flatwashers (40), two nuts (40.1) and plate (41).

16 Remove two screws (39), two flatwashers (40), two nuts (40.1) and plate (41).
17 Remove four screws (42), four lockwashers (43) and light switch (44).
18 Remove cover (45), two screws (46), two flatwashers (47), two lockwashers (48) and auxiliary oulet (49).

c. Assembly



1 To assemble driver's instrument panel, apply a light coating of electrical coating compound (Item 62, App C) to lamp sockets.

1.1 Reverse steps 17 through 12 of disassembly.

2 To assemble portable instrument panel, apply a light coating of electrical coating compound (Item 62, App C) to lamp sockets.

2.1 Install coolant indicator LED (1) and hexnut (2).

3 Install six indicators (3), six brackets (4) with 12 lockwashers (5) and 12 nuts (6).

4 Install shield light assembly (7) and four light brackets (8) with eight screws (9) and eight washers (10).

5 Install master switch (11), switch guard (12), identification plate (13), with two lockwashers (14), two flatwashers (15) and two screws (16).

6 Screw two lamp assemblies (17) into front of portable panel.

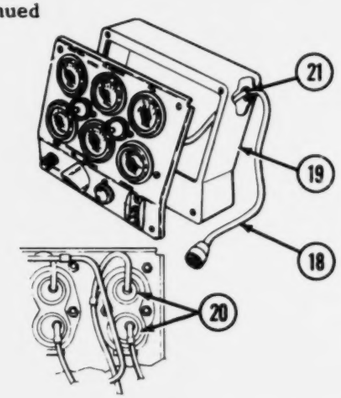
6.1 Screw two LED assemblies (17.1) into front of portable instrument panel.

TA472250

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-14. PORTABLE AND DRIVER'S INSTRUMENT PANELS - CONTINUED

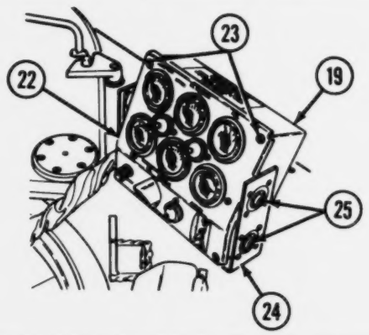
c. Assembly - Continued



7 Install harness assembly (18) onto portable instrument panel cover (19).

8 Connect all electrical connectors (20) to the back of panel.

9 Install grommet (21) and remove slack from harness assembly (18).

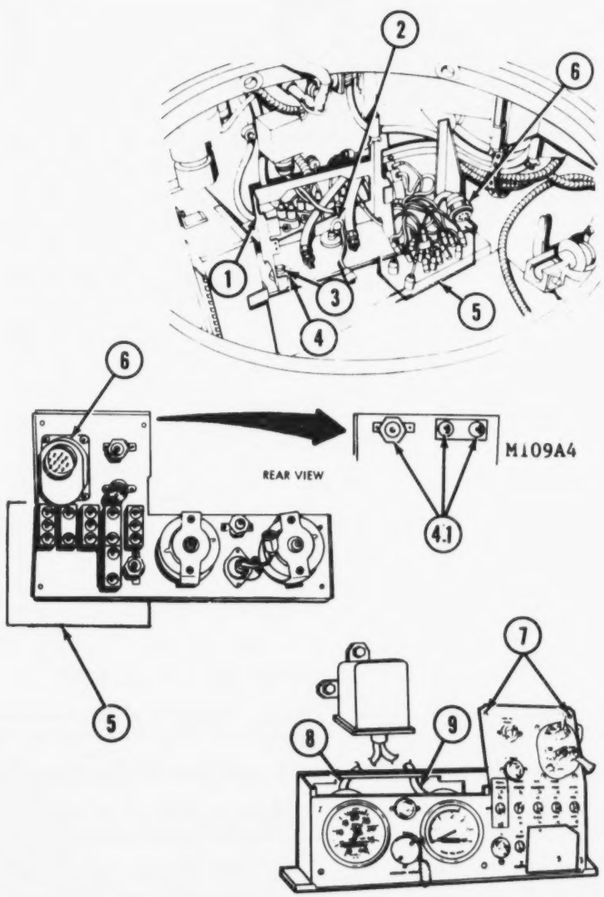


10 Position front panel (22) onto panel cover (19) and connect the four stud fasteners (23).

11 Position portable instrument panel inside bracket assembly (24) and secure with four crosspoint screws (25).

TA472251

d. Installation



1 To install driver's instrument panel, install mounting support (1).

2 Install ground strap (2) with four screws (3) and four washers (4).

3 Position driver's instrument panel into mounting support (1).

3.1 For M109A4 vehicles connect three connectors (4.1) at back of panel (ref. p. 8-30).

4 Connect 20 instrument panel connectors (5) and light switch connector (6) at the back of the panel (ref. p. 8-30).

5 Connect panel with six stud fasteners (7) by pushing in with a screwdriver and turning clockwise.

NOTE

Be certain not to switch cables.

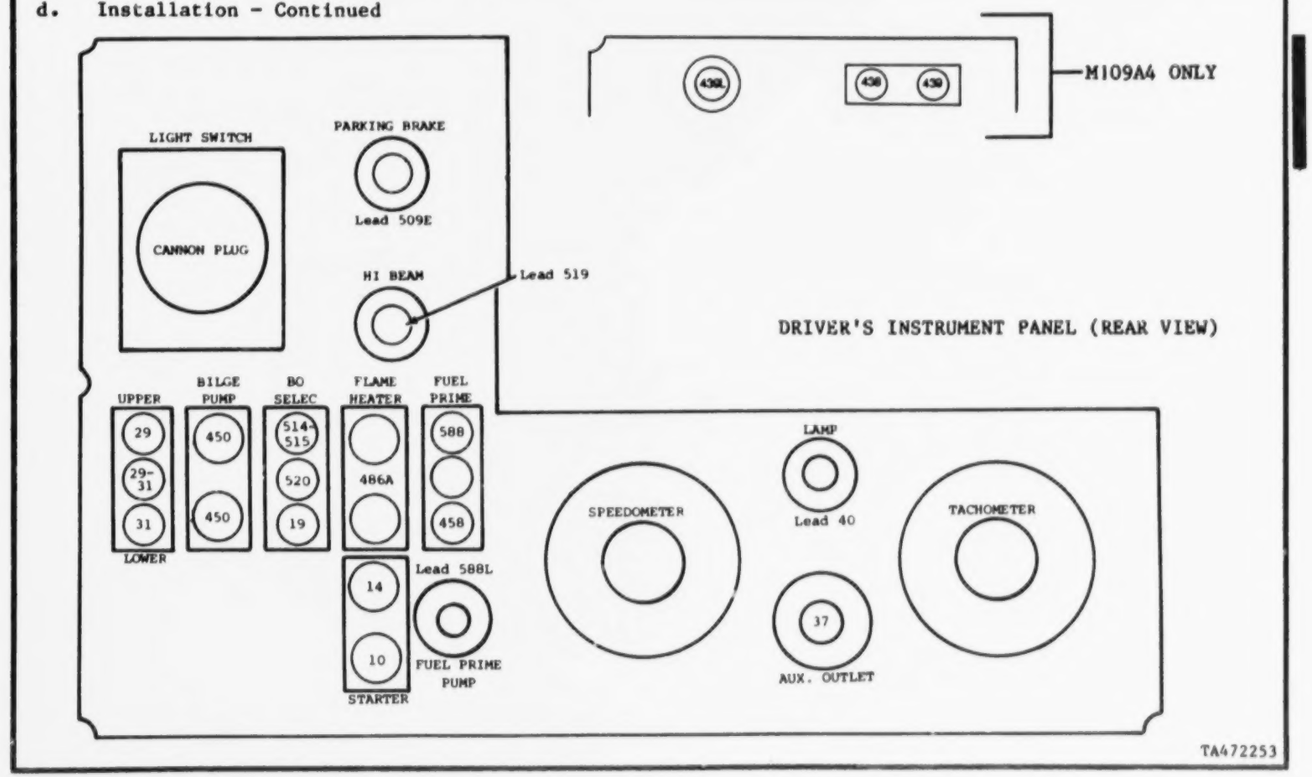
6 Install flexible tachometer cable (8) and flexible speedometer cable (9).

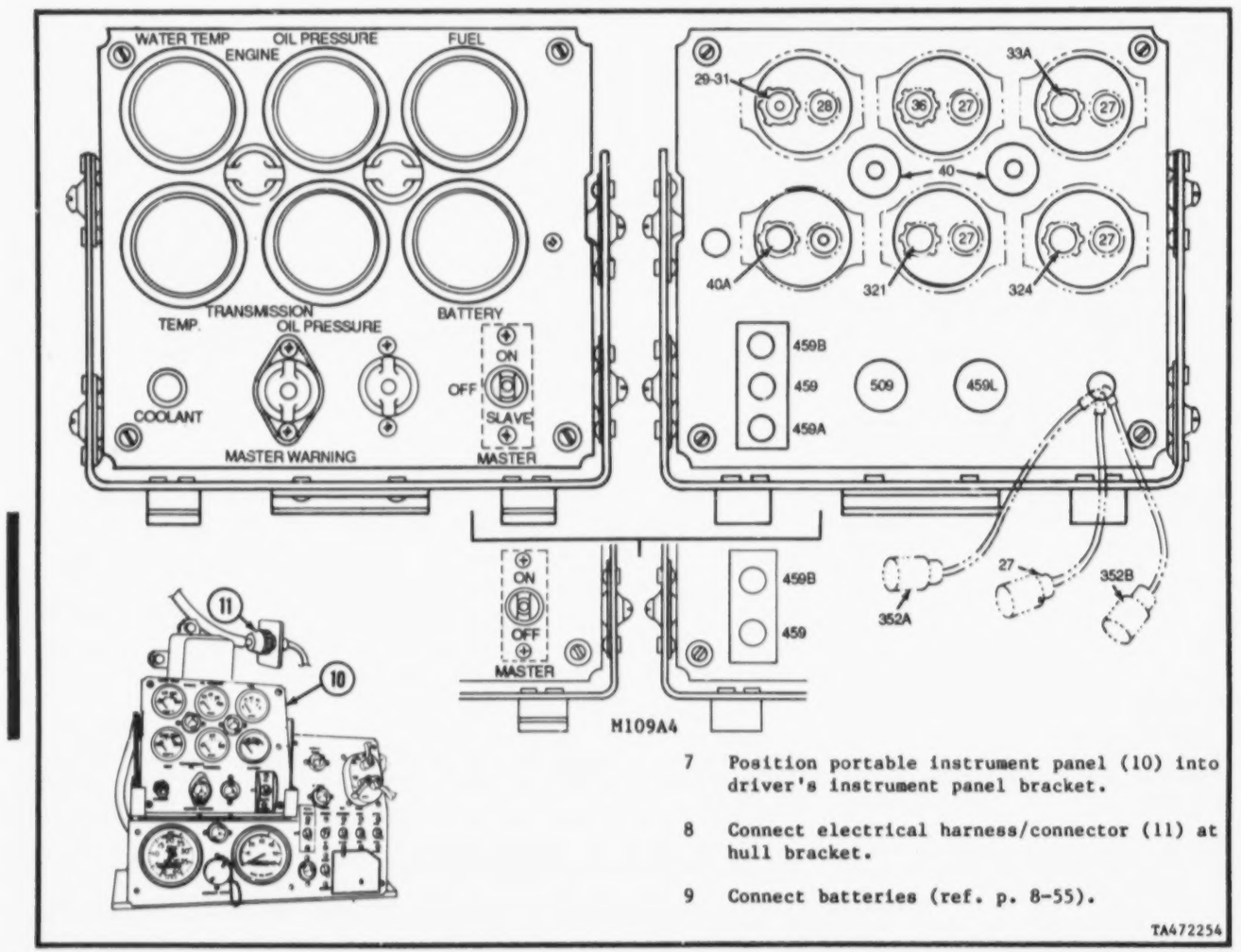
TA472252

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-14. PORTABLE AND DRIVER'S INSTRUMENT PANELS - CONTINUED

d. Installation - Continued





7 Position portable instrument panel (10) into driver's instrument panel bracket.

8 Connect electrical harness/connector (11) at hull bracket.

9 Connect batteries (ref. p. 8-55).

TA472254

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-15. ACCESSORY CONTROL BOX

This task covers:

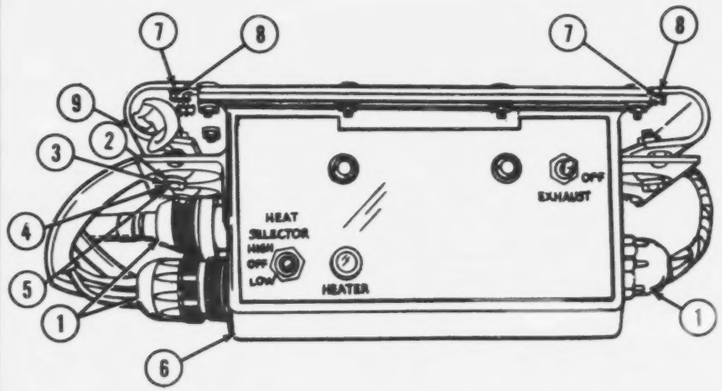
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

Personnel required
2

Materials/Parts
Gasket
Electrical Coating Compound (Item 62, App C)

a. Removal



WARNING

Be certain MASTER switch is OFF when working on accessory control box to avoid electrical shock and burns.

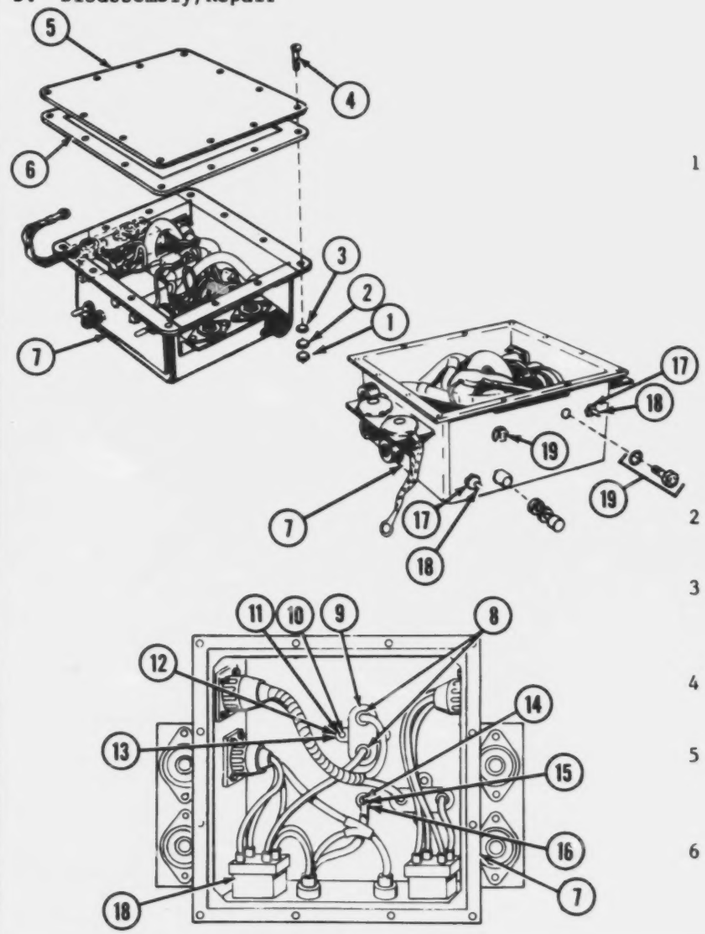
1 Disconnect three electrical connectors (1).

2 Remove four screws (2), four flatwashers (3), four lockwashers (4) and four nuts (5) while supporting accessory control box (6).

3 Remove four screws (7), four washers (8) and two mounting brackets (9).

TA472255

b. Disassembly/Repair



NOTE

Some accessory control boxes may have additional wiring for the flotation blower. This wiring is no longer used.

1 Remove 12 nuts (1), 12 lockwashers (2), 12 flatwashers (3) and 12 screws (4). Lift off cover (5) and gasket (6) from accessory control box (7). Discard gasket if torn, worn or broken.

NOTE

Refer to Appendix D, ref. p. 3-89, Personnel Heater, and ref. p. 3-93 Personnel Ventilation Blower for Accessory Control Box Wiring (Identification/Schematic).

2 Disconnect four electrical connectors (8) at circuit breakers (9).

3 Remove four screws (10), four flatwashers (11), four lockwashers (12) and four nuts (13). Remove two circuit breakers (9).

4 Remove screw (14), two flatwashers (15) and nut (16).

5 Unscrew two hexnuts (17) and pull two switches (18) into accessory control box (7).

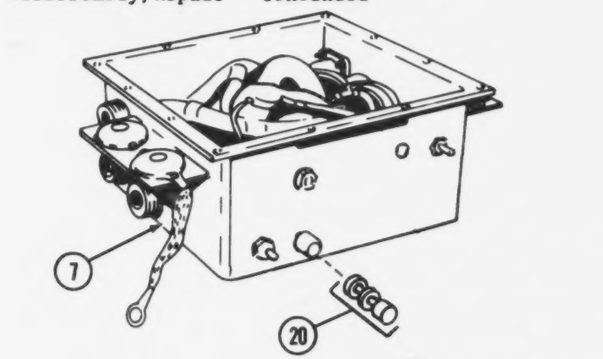
6 Unscrew and remove two panel light LED's and gaskets (lamp assemblies) (19). Pull light bracket into accessory control box (7).

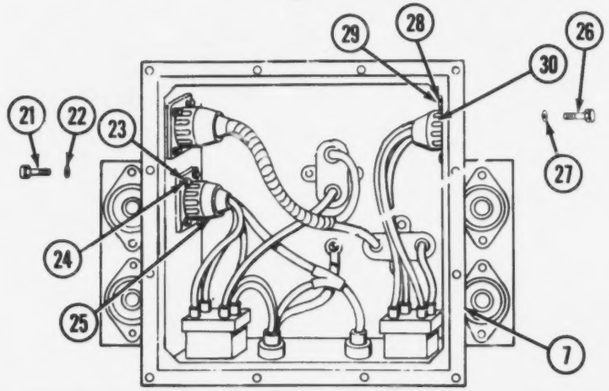
TA472256

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-15. ACCESSORY CONTROL BOX - CONTINUED

b. Disassembly/Repair - Continued





NOTE

To remove electrical connectors to lamp assemblies and/or switches, unsolder points of connection.

7 Remove indicator lamp cap, LED, gasket and hexnut (indicator light lamp assembly) (20). Pull indicator light bracket into accessory control box (7).

8 Remove eight screws (21), eight flatwashers (22), eight lockwashers (23) and eight nuts (24). Remove two electrical connectors (25).

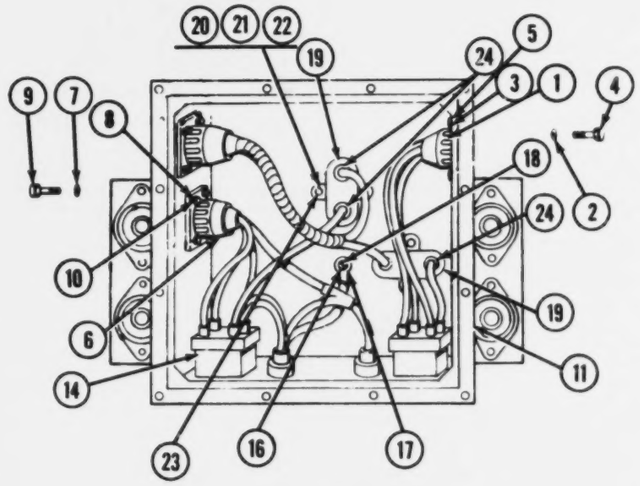
9 Remove four screws (26), four flatwashers (27), four lockwashers (28) and four nuts (29). Remove electrical connector (30).

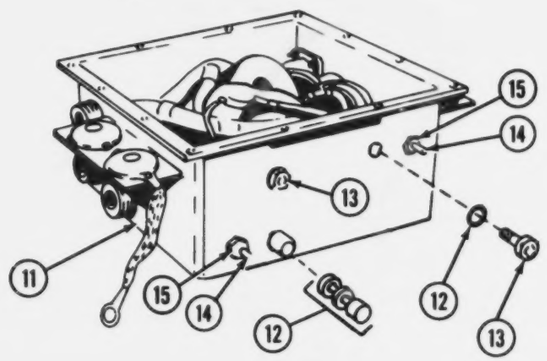
TA472257

c. Assembly

CAUTION

To avoid damaging wiring, use only resin core solder to connect wires to terminal.





1 Install electrical connector (1), four flatwashers (2), four lockwashers (3), four screws (4) and four nuts (5).

2 Install two electrical connectors (6), eight flatwashers (7), eight lockwashers (8), eight screws (9) and eight nuts (10).

3 Push indicator light bracket into accessory control box (11).

3.1 Apply light coating of electrical coating compound (Item 62, App. C) to three bulb sockets.

4 Replace gasket of indicator light lamp assembly (12) if torn, worn or broker. Install indicator LED, hexnut and cap of same assembly.

5 Push light bracket into accessory control box (11).

6 Replace two gaskets (12) if torn, worn or broken, and screw in two panel light LED's of lamp assemblies (13).

7 Push two switches (14) into accessory control box (11), and screw in two hexnuts (15).

8 Install two flatwashers (16), screw (17) and nut (18).

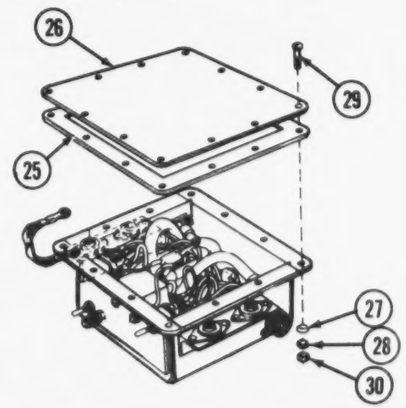
9 Install two circuit breakers (19), four flatwashers (20), four lockwashers (21), four screws (22) and four nuts (23).

10 Connect four electrical connectors (24) at circuit breakers (19).

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-15. ACCESSORY CONTROL BOX - CONTINUED

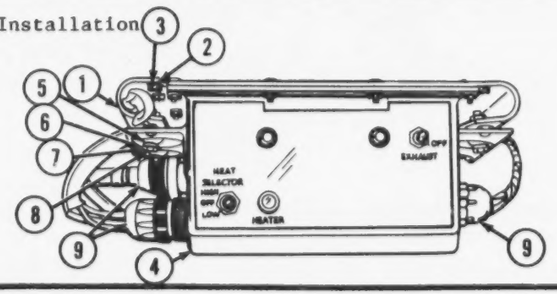
c. Assembly - Continued



11 Replace accessory control box gasket (25) if torn, worn or broken and install cover (26).

12 Install 12 flatwashers (27), 12 lockwashers (28), 12 screws (29) and 12 nuts (30).

d. Installation



1 Install two mounting brackets (1) with four washers (2) and four screws (3).

2 Position accessory control box (4) on mounting brackets and install and tighten four nuts (5), four lockwashers (6), four flatwashers (7) and four screws (8).

3 Connect three electrical connectors (9).

TA472259

8-16. HEADLIGHTS

This task covers:

a. Alignment b. Removal c. Installation d. Adjustment

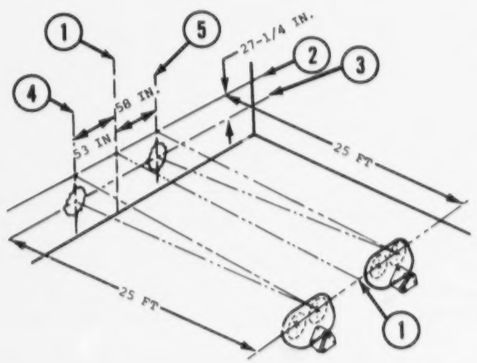
INITIAL SET-UP

Materials/Parts
Silicone Compound (Item 62, App C)

a. Alignment

NOTE

Alignment of lights should be in shaded or dimly lit areas.



1 Park vehicle on level ground or pavement 25 feet (7.68M) from a wall.

2 Draw a line (1) perpendicular to the wall or screen, passing through the center of the vehicle.

3 Measure the distance from the center of the sealed lamp unit (service side, clear) to the ground. Duplicate this measurement on the wall drawing a horizontal centerline (2) of lamp unit.

4 Draw a line (3) parallel to and 27-1/4 inches (69.2cm) below line (2).

5 Draw a line (4) parallel to and 53 inches (1.3M) left of the centerline of vehicle.

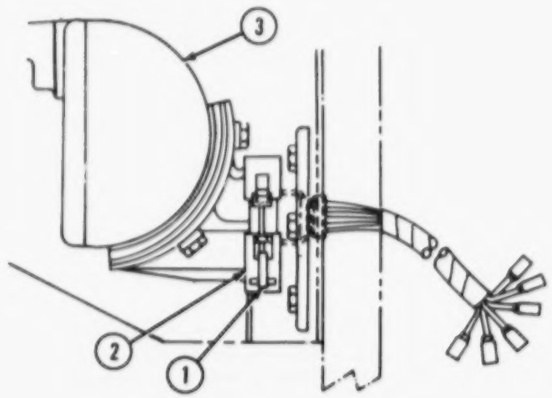
6 Draw a line (5) parallel to and 58 inches (1.5 M) right of the centerline of vehicle.

7 Turn on lights to low beam. The center of left beam's highest light intensity should be where lines (3 and 4) cross. Center of the right beam's highest light intensity should be where lines (3 and 5) cross. Adjust if necessary (ref. page 8-39).

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-16. HEADLIGHTS - CONTINUED

b. Removal



1 Pull T handle locking device (1) upward.

2 Remove retaining clamp (2).

CAUTION

Do not twist headlight assembly during removal or installation. Damage to connectors may result.

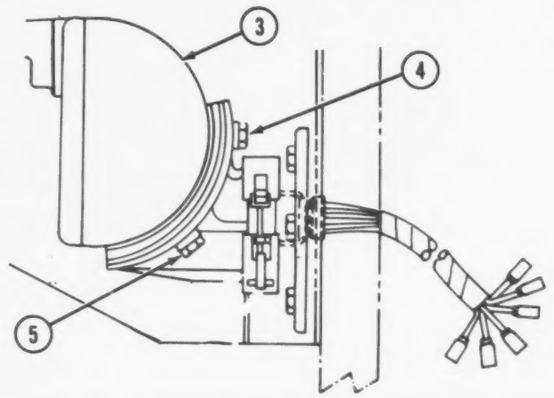
3 Pull headlight assembly (3) straight out.

c. Installation

1. Apply silicone compound (Item 62, App C) to electrical connector pins.
2. Install in reverse order of removal.

TA472261

d. Adjustment



1 Remove headlight assembly (3).

2 Loosen two nuts (4) and two nuts (5).

3 Install headlight assembly (3).

4 Manually adjust headlight assembly to alignment marks (ref. p. 8-37).

5 Tighten two nuts (5).

6 Remove headlight assembly (3).

7 Tighten two nuts (4).

8 Install headlight assembly (3).

TA472262

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-17. HEADLIGHT SEALED-BEAM AND INCANDESCENT LAMPS

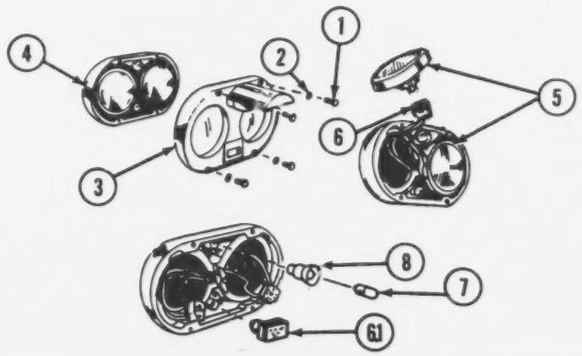
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Electrical Coating Compound (Item 62, App. C)
Anti-seize Compound (Item 63, App. C)
Grease (Item 65, App. C)

a. Removal



1 Remove four screws (1), four washers (2) and cover group (3) from headlight mount (4).

2 Pull two sealed-beam units (5) out of recess.

3 Disconnect two electrical connectors (6) from sealed-beam units.

3.1 Snap open marker assembly cover. Using screwdriver push in and turn assembly hose base. Remove marker assembly (6.1) from socket.

4 Remove blackout drive reflector (7).

CAUTION

Halogen blackout lamp must be kept free of dirt, oil, grease, fingerprints etc. Failure to do so can result in damage to bulb.

5 Push blackout lamp (8) in, turn counterclockwise and remove.

b. Installation

1 Apply light coating of electrical coating compound (Item 62, App C) to lamp sockets.

2 Apply light coating of grease (Item 65, App C) to cover (3) contact surfaces.

3 Apply anti-seize compound (Item 63, App C) to threads of screws (1).

4 Install in reverse order of removal.

8-18. HEADLIGHT ASSEMBLY GROUP

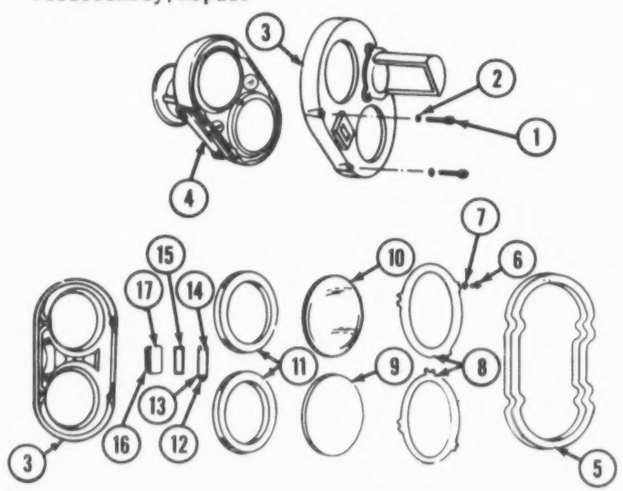
This task covers:

a. Disassembly/Repair b. Assembly

INITIAL SET-UP

Materials/Parts
- Gaskets (4)
- Adhesive (Item 64, App C)
- Sealing Compound (Item 46, App. C)
- Grease (Item 65, App C)
- Anti-seize Compound (Item 63, App C)

a. Disassembly/Repair



1 Remove four screws (1), four washers (2) and cover group (3) at headlight mount (4).

2 Disassemble the cover group (3). Remove the following components:

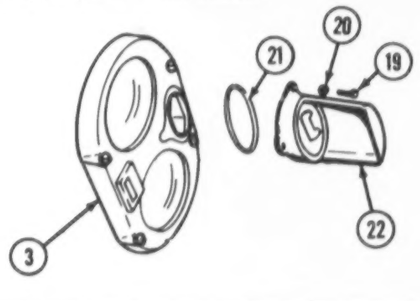
Gasket (5) - discard gasket (5)
Six screws (6) and lockwashers (7),
Two gaskets (8),
Blackout lens (9)
Service headlight lens (10),
Two gaskets (11)
Two screws (12) and lockwashers (13),
Retainer (14), gasket (15), filter (16),
lens (17).

TA472264

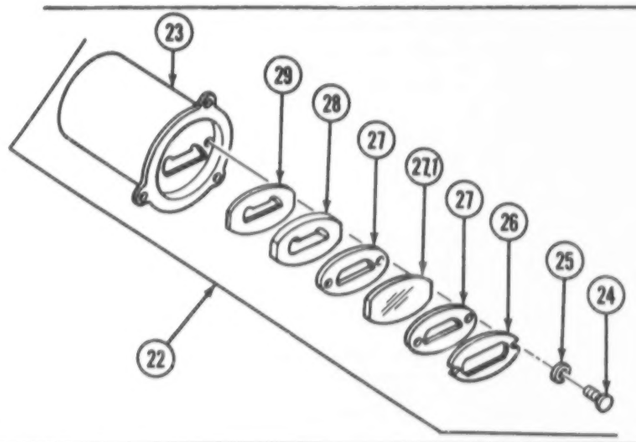
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-18. HEADLIGHT ASSEMBLY GROUP - CONTINUED

a. Disassembly/Repair - Continued



3 Remove three screws (19) and three lockwashers (20), gasket (21) and blackout drive light shield group (22). Discard gasket (21).



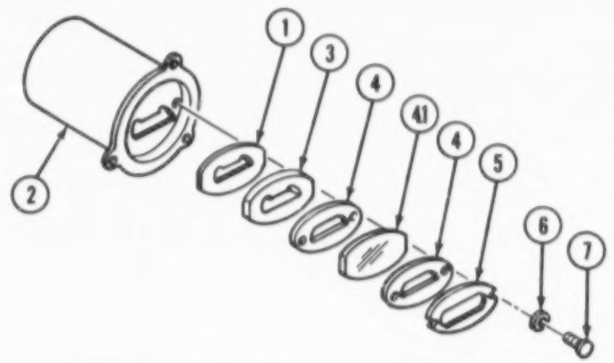
4 Disassemble blackout drive light shield group (22).

5 Remove components from the shield (23) as follows:

Two screws (24) and two lockwashers (25),
Retainer (26),
Two Gaskets (27),
Blackout Filter (27.1),
Lens (28),
Gasket (29) - discard gasket (29).

TA472265

b. Assembly



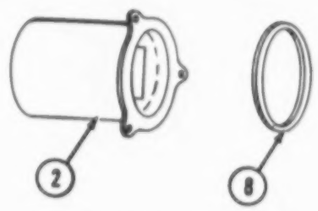
NOTE

Caution should be used when installing the following components to prevent light leakage from around filter.

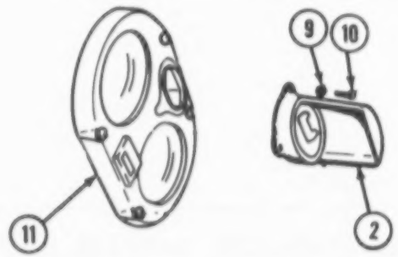
1 Apply gasket (1) to shield (2) with sealing compound (Item 46, App. C).

2 Install these components in shield (2) after gasket (1) has been positioned:

Lens (3),
Two Gaskets (4)
Blackout Filter (4.1)
Retainer (5),
Two Lockwashers (6) and two screws (7).



3 Cement gasket (8) to shield (2). Use adhesive (Item 64, App C). Apply a light coating of grease (Item 65, App C) to contact sufaces.



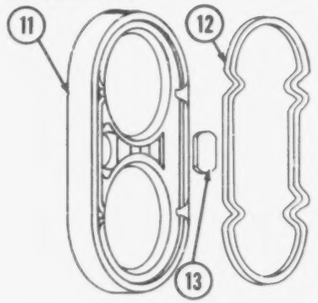
4 Apply anti-seize compound (Item 63, App. C) to threads of screws (10). Install shield (2) with three lockwashers (9) and three screws (10) to cover (11).

TA472266

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

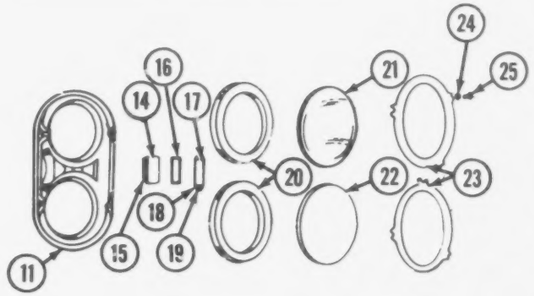
8-18. HEADLIGHT ASSEMBLY GROUP - CONTINUED

b. Assembly - Continued



5 Cement gasket (12) to cover (11). Use adhesive (Item 64, App C).

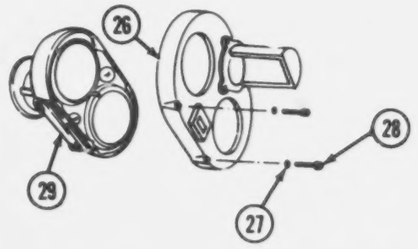
6 Apply gasket (13) with sealing compound to cover (11). Use sealing compound (Item 46, App. C).



7 Apply anti-seize compound (Item 63, App C) to threads of screw (25). Install the following components in cover (11):

Lens (14),
Filter (15),
Gasket (16),
Retainer (17),
Two lockwashers (18) and two screws (19),
Two gaskets (20),
Service headlight lens (21),
Blackout lens (22),
Two gaskets (23),
Six lockwashers (24) and six screws (25).

TA472267



7.1 Apply a light coating of grease (Item 65, App C) to cover (26) contact surfaces. Apply anti-seize compound (Item 63, App C) to threads of screws (28).

8 Install cover group (26) with four washers (27) and four screws (28) at headlight mount (29).

TA472268

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-19. HEADLIGHT MOUNT

This task covers:

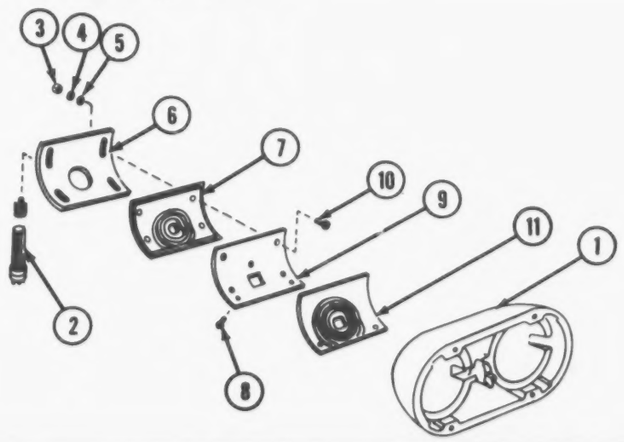
a. Disassembly/Repair b. Installation

INITIAL SET-UP

Materials/Parts

Electrical Coating (Item 62, App C)
Anti-seize compound (Item 63, App C)

a. Disassembly/Repair



WARNING

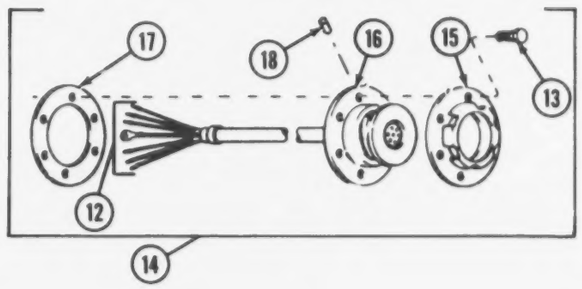
Be certain MASTER switch is OFF when working on headlight mount to avoid electrical shock and burns.

1 Remove headlight sockets from headlight body (1) (ref. p. 8-41).

2 Remove headlight wiring harness (2) from headlight body (1).

3 Remove four nuts (3), four lockwashers (4) and four flatwashers (5) from headlight body (1).

4 Remove mounting bracket (6) and gasket (7) from headlight body (1).



5 Remove three screws (8), plate (9), four screws (10) and gasket (11) from headlight body (1).

6 Disconnect electrical harness terminals (12) at harness 10921380 (ref. p. D3/D4).

7 Remove six screws (13).

8 Remove hull mount assembly (14) from hull.

9 Separate retainer (15), mount assembly (16) and gasket (17).

10 Remove guide pin (18).

c. Assembly

1 Apply anti-seize compound (Item 63, App. C) to the threads of screws (10).

2 Apply light coating of electrical coating (Item 62, App. C) to electrical harness connectors.

3 Assemble in reverse order of disassembly.

TA472270

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-20. SERVICE AND BLACKOUT TAILLIGHTS, STOPLIGHTS AND LAMPS

This task covers:

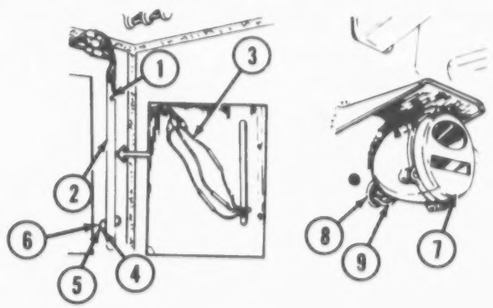
a. Removal b. Installation

INITIAL SET-UP

Materials/Parts

Electrical Coating Compound (Item 62, App C)
Anti-seize Compound (Item 63, App C)

a. Removal



NOTE

Taillight need not be removed from vehicle to replace LED's.

WARNING

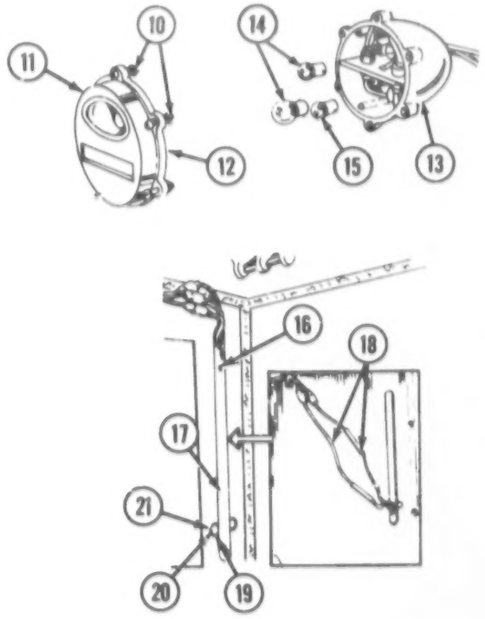
Be certain MASTER switch is OFF when working on light to avoid electrical shock and burns.

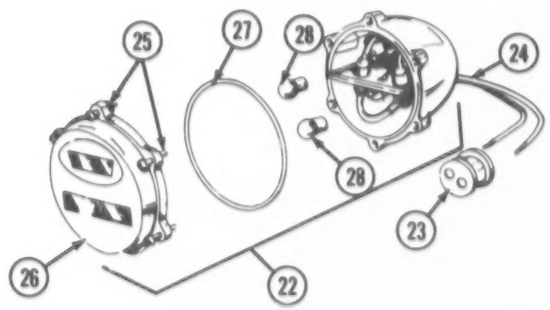
1 To remove service taillight, remove two screws (1) and cover plate (2) from inside hull.

2 Disconnect three electrical connectors (3).

3 Remove two screws (4), two flatwashers (5) and two lockwashers (6) from inside hull.

4 Remove taillight assembly (7), grommet (8) and electrical leads (9) from outside hull.





5 To remove LED's, unscrew six screws with retaining rings (10).

6 Separate door (11) with grommet (12) from body (13).

7 Push in, turn counterclockwise and remove two LED's (14).

7.1 Using a screwdriver inserted into the marker assembly center slot, push in and turn marker assembly (15) base counterclockwise and remove from socket.

8 To remove blackout taillights, remove two screws (16) and cover plate (17).

9 Disconnect two electrical connectors (18).

10 Remove two screws (19), two flatwashers (20) and two lockwashers (21).

11 Remove taillight assembly (22), grommet (23) and electrical leads (24).

12 To remove LED's, loosen six screws with retaining rings (25).

13 Remove door (26) with grommet (27).

14 Open stop lamp assembly (28) housing cover. Insert a screwdriver into the center slot, push in and turn base counterclockwise. Remove stop lamp from socket.

15 Insert screwdriver in marker assembly (29) center slot. Push in and turn counterclockwise. Remove marker.

b. Installation

1 Lightly apply electrical coating compound (Item 62, App C) lamp sockets.

2 Apply anti-seize compound (Item 63, App C) to screw (25) threads.

3 Install in reverse order of removal.

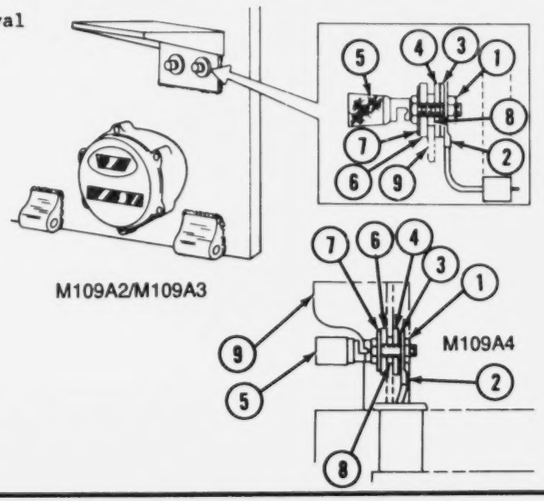
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-21. TELEPHONE TERMINAL

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Be certain MASTER switch is OFF when working on telephone terminal to avoid electrical shock and burns.

NOTE

Position of telephone terminals is different on M109A2/M109A3 and M109A4 vehicles.

1 Remove nut (1).

2 Remove cable (2), flatwasher (3) and non-metallic washer (4).

3 Remove telephone terminal (5), non-metallic washer (6), flatwasher (7) and non-metallic washer (8) from bracket (9).

b. Installation

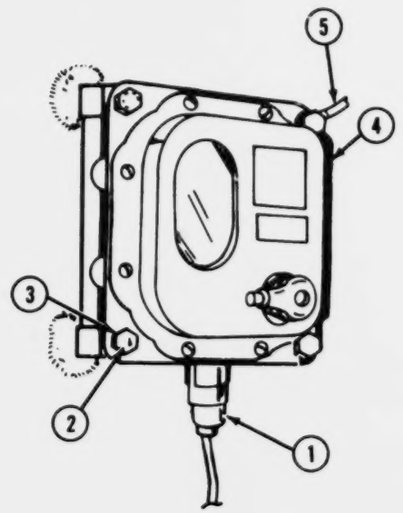
Install in reverse order of removal.

8-22. DOME LIGHT

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock and burns.

NOTE

For installation of dome light, a blue lens will replace red lens per TB 9-2300-421-20, 21 Jun 82 (ref. TM 9-2350-311-24P-1).

1 Disconnect electrical lead (1).

2 Remove four screws (2) and four lockwashers (3) and dome light (4). On M109A4 vehicles, ground lead (5) will be disconnected.

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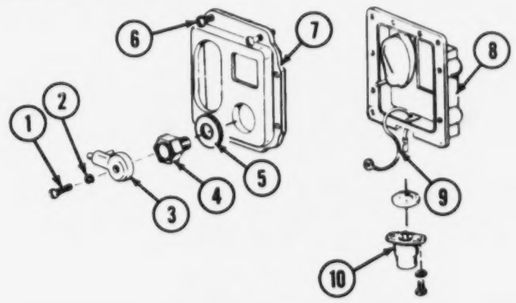
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-22. DOME LIGHT - CONTINUED

b. Disassembly/Repair

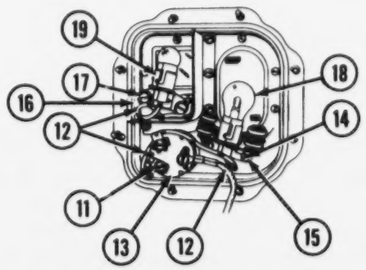


1 Remove screw (1), lockwasher (2), switch knob (3), nut (4) and flatwasher (5).

2 Loosen eight screws and retaining rings (6).

3 Separate dome light door assembly (7) from light body (8).

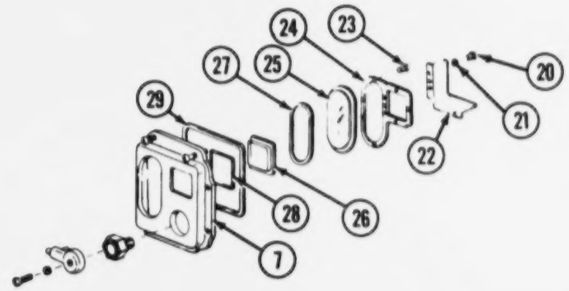
4 Disconnect electrical lead (9) at connector assembly (10). Remove door assembly (7) from body (8).



5 Remove three screws (11) and three electrical leads (12) at switch (13). Remove switch (13).

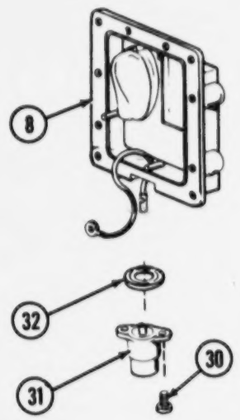
6 Remove two crosspoint screws (14), two lockwashers (15), two screws (16), two flatwashers (17), lamp assembly (18) and lamp assembly (19) from door.

TA472275



7 Remove four crosspoint screws (20), four lockwashers (21) and partitions (22).

8 Remove seven crosspoint screws (23), plate (24), lens (25) and (26), and gaskets (27), (28) and (29) from door assembly (7).



9 Remove two crosspoint screws (30), connector assembly (31) and grommet (32) from dome light body (8).

c. Assembly

Assemble in reverse order of disassembly.

NOTE

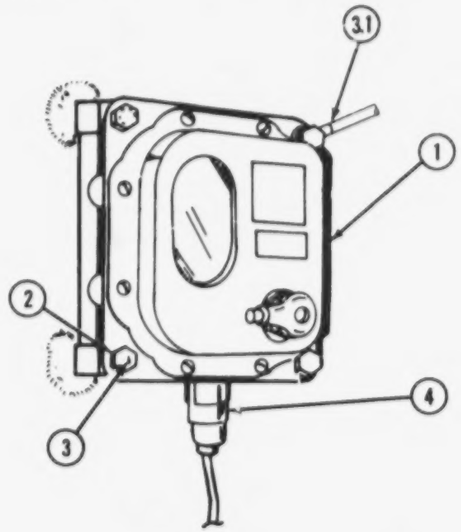
Red lens on dome light must be replaced with blue lens per TB 9-2300-421-20, 21 Jun 82.

TA472276

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-22. DOME LIGHT - CONTINUED

d. Installation



1 Install dome light (1) with four lockwashers (2) and four screws (3). On M109A4 vehicles, connect ground lead (3.1) under one screw (3).

2 Connect electrical lead (4).

TA472277

8-23. BATTERY

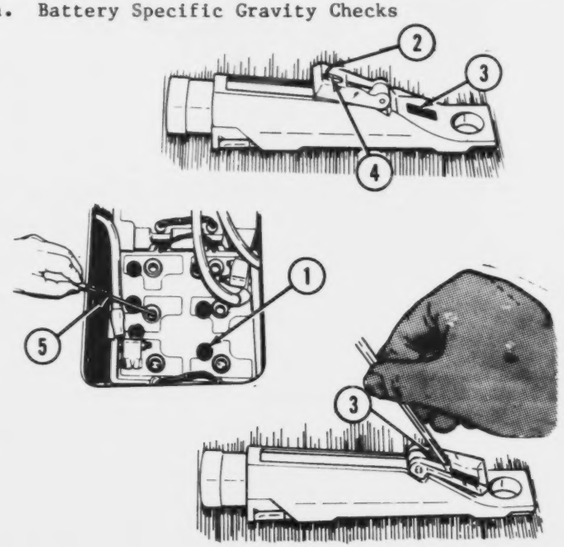
This task covers:

a. Battery Specific Gravity Check b. Removal c. Installation

INITIAL SET-UP

Test equipment
Duo tester (Item 42, App. B), Multimeter

a. Battery Specific Gravity Checks



TA472278

WARNING

When working on batteries, wear eye protection and remove all jewelry, dogtags and metal items to avoid electrical shock and burns.

CAUTION

When removing batteries always disconnect ground cables first to prevent damage to batteries.

1 Remove battery caps (1) from all cells. Repeat steps 2 through 5 for each cell.

2 Swing plastic cover (2) back on duo-check coolant and battery tester. Clean the measuring surface (3) and the bottom cover (4) with a clean soft cloth. Close cover.

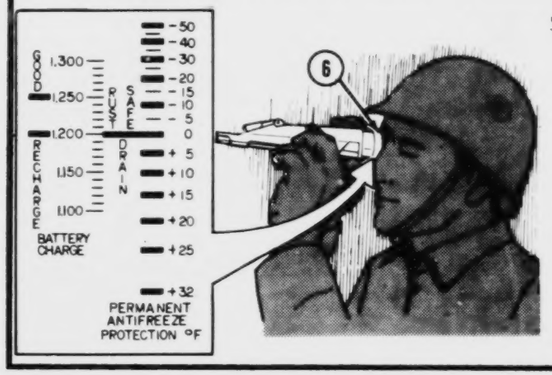
3 Use black dipstick (5) to obtain a small sample of battery acid.

4 Place a few drops of acid onto measuring surface (3) though opening in cover plate.

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-23. BATTERY - CONTINUED

a. Battery Specific Gravity Checks - Continued



5 Point the instrument toward any light source (headlight) and look into eyepiece (6). The battery charge is at a point on the left-hand part of the scale where the dividing line between light and dark (shadow) crosses the scale.

NOTE

A little experience will enable you to quickly obtain the best contrast between light and dark portions of the field of view. Tilt the instrument toward the light source until the best results are obtained. If the edge of the shadow is not sharp, the measuring surface was not sufficiently cleaned or dried.

b. Removal

WARNING

When working on batteries, wear eye protection and remove all jewelry, dogtags and metal items to avoid electrical shock and burns.

CAUTION

When removing batteries, always disconnect ground leads first.

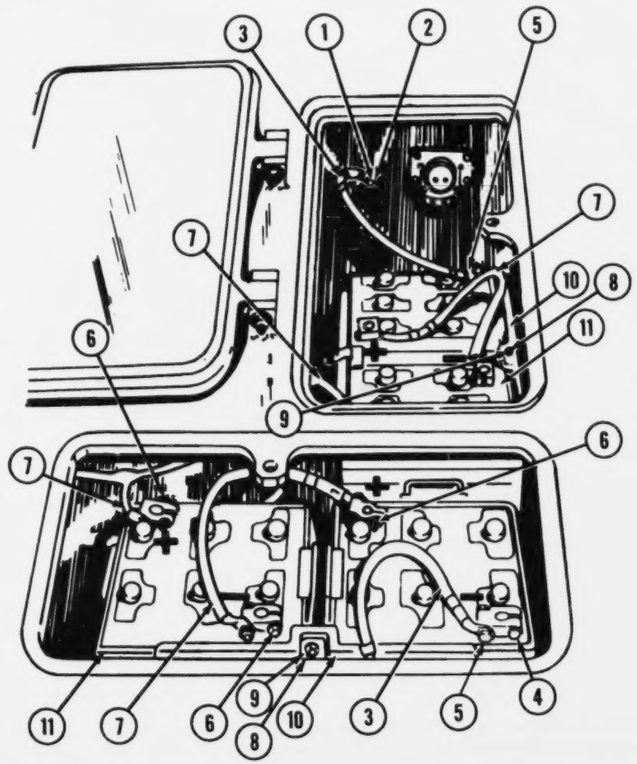
1 Remove two screws (1), four lockwashers (2) and ground cables (3) (ref. TM 9-6140-200-14).

2 Loosen two screws (4).

3 Remove two ground cable lugs (5) from battery.

4 Loosen six nuts (6).

TA472279



5 Remove four cables (7) from battery with lugs attached.

6 Remove two nuts (8), washer (9), and holddown brackets (10).

7 Lift batteries (11) out of battery compartment.

c. Installation

Install in reverse order of removal.

TA472280

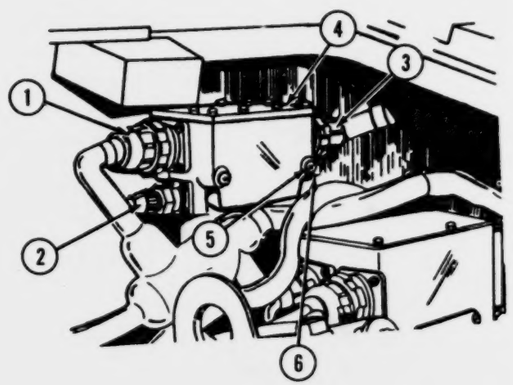
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-24. MASTER RELAY BOX

This task covers:

a. Removal b. Installation

a. Removal



1 Disconnect battery ground cables (ref. p. 8-56).

2 Disconnect starter cable connecter (1), master switch cable connector (2) and battery cable connector (3) at master relay box (4).

3 Remove two screws (5) and two washers (6).

4 Remove master relay box (4).

b. Installation

Install in reverse order of removal.

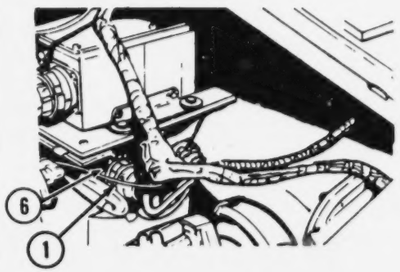
TA472281

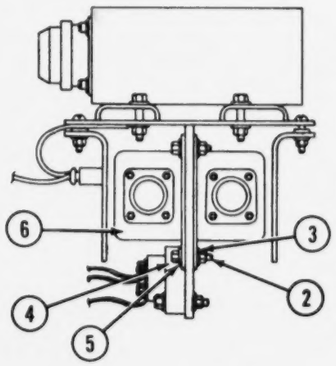
8-25. BILGE PUMP RELAY

This task covers:

a. Removal b. Installation

a. Removal





WARNING

Be certain MASTER switch is off when working on bilge pump relay to avoid electrical shock and burns.

1 Disconnect electrical connector (1).

2 Remove and save two nuts (2), two lockwashers (3), two flatwashers (4) and two screws (5).

3 Remove bilge pump relay box (6).

4 Replace two nuts (2), two lockwashers (3), two flatwashers (4) and two screws (5) to hold starter relay.

b. Installation

Install in reverse order of removal.

TA472282

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-26. STARTER RELAY BOXES

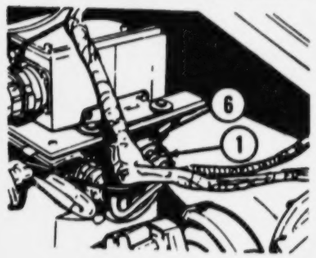
This task covers:

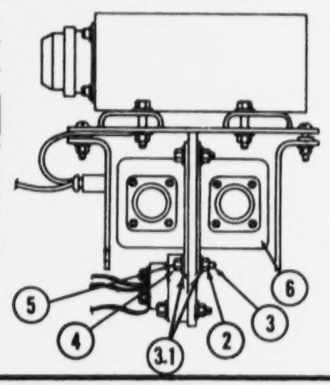
a. Removal b. Installation

a. Removal

NOTE

The following procedure applies to either the starter switch relay box (M109A2/M109A3) or the starter protection relay box (M109A4).





WARNING

Be certain MASTER switch is OFF when working on starter switch relay boxes to avoid electrical shocks and burns.

1 Disconnect electrical connector (1).

2 Remove and save two nuts (2), two lockwashers (3), four external tooth washers (3.1), two flatwashers (4), and two screws (5).

3 Remove starter relay box or starter protection relay box (6).

4 Replace two nuts (2), two lockwashers (3), four external tooth washers (3.1), two flatwashers (4) and two screws (5) to hold bilge pump relay.

b. Installation

Install in reverse order of removal.

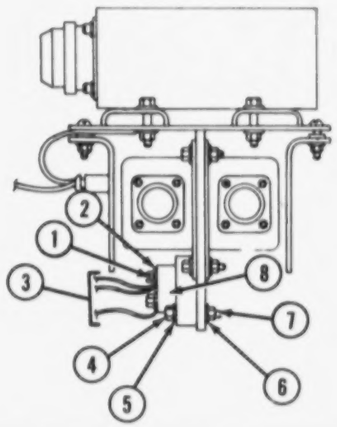
TA472283

8-27. BILGE PUMP CIRCUIT BREAKER

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Be certain MASTER switch is OFF when working on bilge pump circuit breaker to avoid electrical shock and burns.

1 Remove two screws (1) and two washers (2).

2 Remove three electrical leads from circuit breaker (3).

3 Remove two screws (4), two flatwashers (5), two lockwashers (6) and two nuts (7).

4 Remove circuit breaker (8).

b. Installation

Install in reverse order of removal.

TA472284

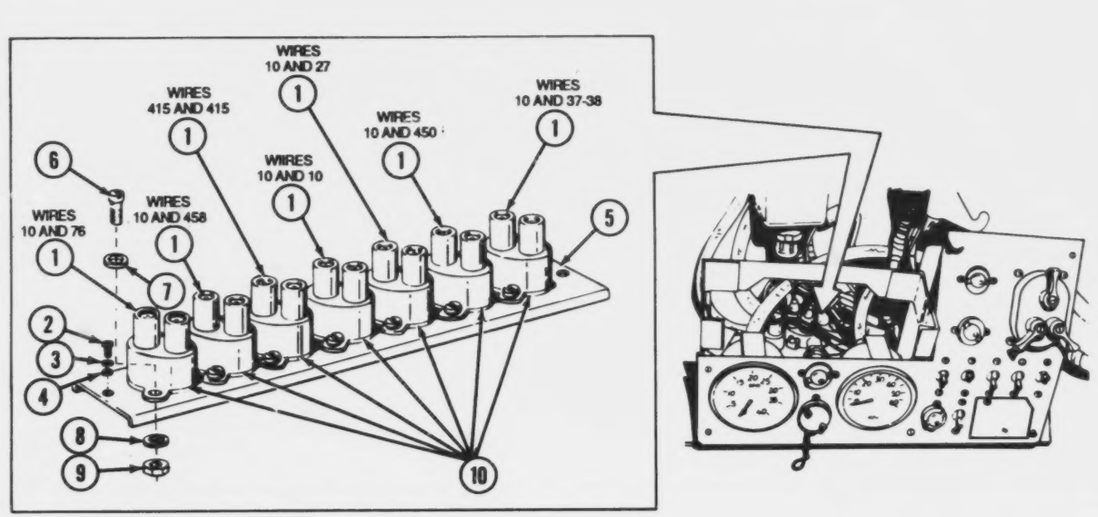
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-28. CIRCUIT BREAKER - M109A2/M109A3

This task covers:

a. Removal b. Installation

a. Removal



TA472285

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock and burns.

1 To remove circuit panel, remove portable and drivers instrument panels (ref. p. 8-22).

2 Disconnect 14 electrical leads (1).

3 Remove two screws (2), two flatwashers (3) and two lockwashers (4).

4 Remove circuit breaker panel (5).

5 To remove individual circuits, first identify problem circuit. Refer to wiring diagrams, Section III, this chapter, and Appendix D.

6 Disconnect identified electrical leads at circuit breaker.

7 Remove two screws (6), two flatwashers (7), two lockwashers (8) and two nuts (9) at identified problem circuit breaker (10).

8 Remove circuit breaker (10).

b. Installation

Install in reverse order of removal.

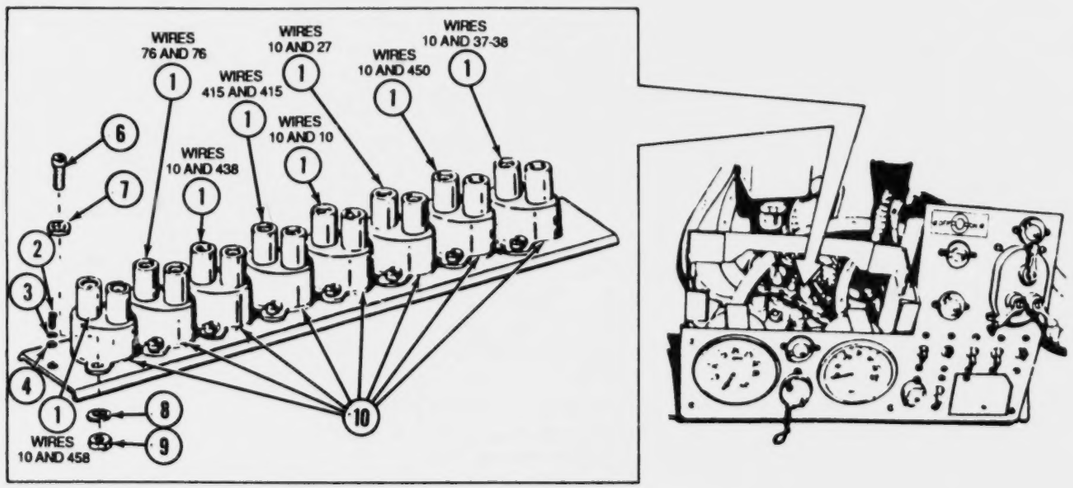
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-28.1. CIRCUIT BREAKER - M109A4

This task covers:

a. Removal b. Installation

a. Removal



a. Removal

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock and burns.

1 To remove circuit panel, remove portable and drivers instrument panels (ref. p. 8-22).

2 Tag and disconnect 16 electrical leads (1).

3 Remove two screws (2), two flatwashers (3) and two lockwashers (4).

4 Remove circuit breaker panel (5).

5 To remove individual circuit breakers, first identify problem circuit. Refer to wiring diagrams, Section III, this chapter.

6 Disconnect identified electrical leads at circuit breaker.

7 Remove two screws (6), two flatwashers (7), two lockwashers (8) and two nuts (9) at identified problem circuit breaker (10).

8 Remove circuit breaker (10).

b. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

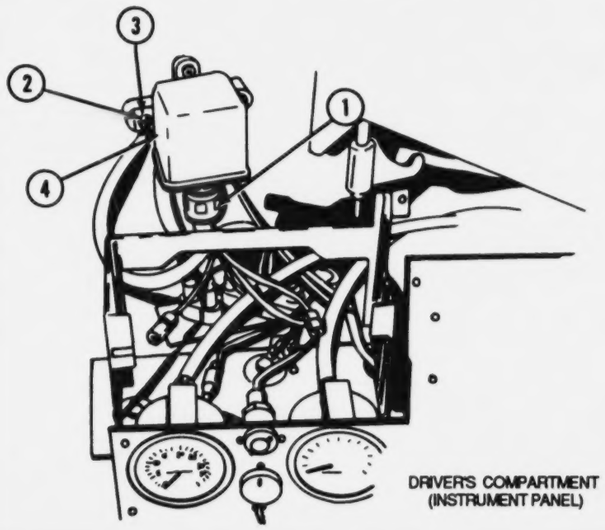
8-29. IN-TANK FUEL PUMPS AND GENERATOR SYSTEM RELAY (M109A4)/ AIR CLEANER BLOWER RELAY (M109A2/M109A3) AND MOTOR

This task covers:

a. Removal b. Installation

a. Removal

NOTE
M109A2/M109A3 pictured.



WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shocks and burns.

NOTE

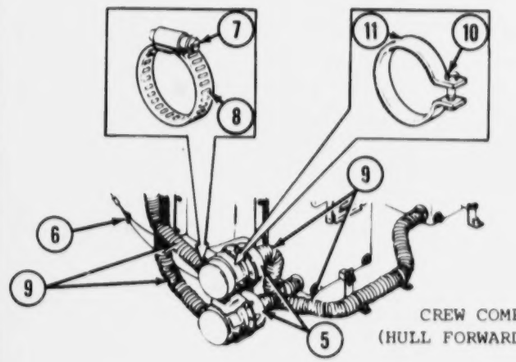
The air cleaner blower relay differs on M109A2/M109A3 and M109A4 vehicles. Refer to page 8-66 for M109A4 relay removal and installation.

1 Remove portable instrument panel (ref. p. 8-22).

2 To remove air cleaner blower motor relay, disconect electrical connector (1).

3 Remove three nuts (2) and three washers (3).

4 Remove air cleaner blower relay (4).



CREW COMPARTMENT
(HULL FORWARD BULKHEAD)

5 To remove air cleaner blower motor (5), disconnect two electrical leads (6).

6 Turn four screws (7) counterclockwise to loosen four clamps (8).

7 Disconnect four hoses (9) from blower motors (5).

8 Loosen two screws (10) to loosen clamps (11).

9 Pull the blower motors out of the clamps (11) to remove.

b. Installation

Install in reverse order of removal.

TA472287

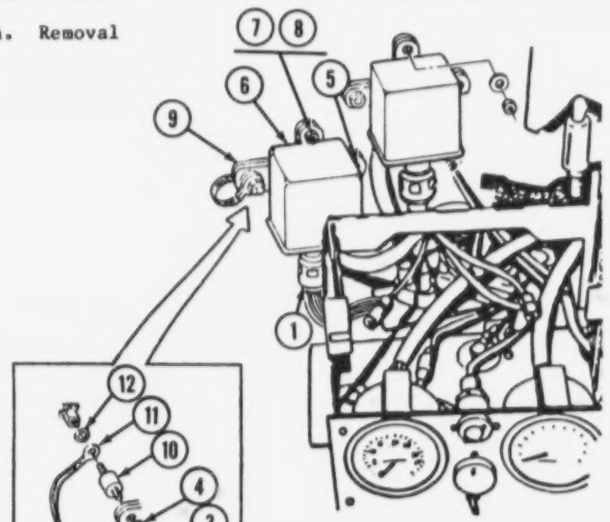
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-29.1 AIR CLEANER BLOWER RELAY (M109A4)

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shocks and burns.

1 Remove portable instrument panel (ref. p. 8-22).

2 To remove air cleaner blower motor relay, disconnect electrical connector (1).

3 Remove nut (2), ground lead end (3) and washer (4).

4 Remove nut (5) and air cleaner blower relay (6).

5 Remove nut (7), flatwasher (8), bracket (9), three mounts (10), ground lead (11) and washer (12).

TA472286

b. Installation

Install in reverse order of removal.

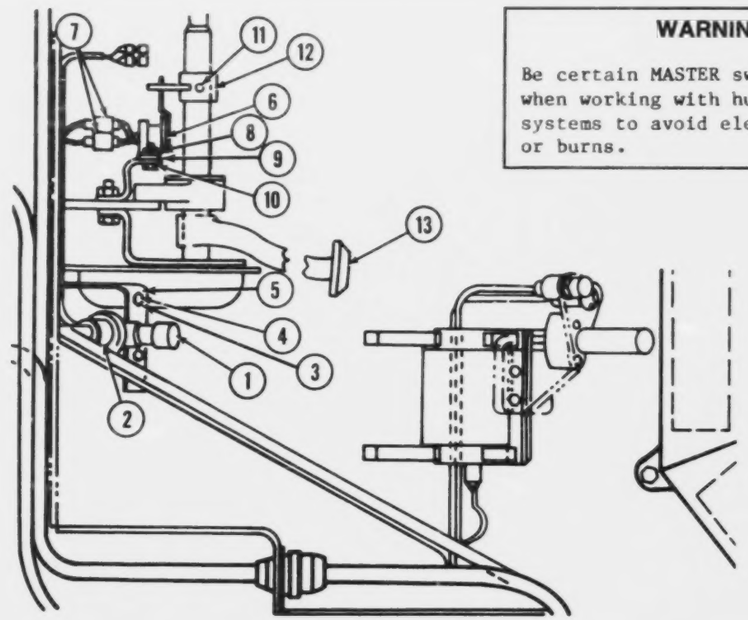
ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-30. HEADLIGHT DIMMER AND STOPLIGHT SWITCHES

This task covers:

a. Removal b. Installation c. Adjustment

a. Removal



WARNING

Be certain MASTER switch is OFF when working with hull electrical systems to avoid electrical shock or burns.

TA472288

1 To remove dimmer switch (1), disconnect electrical plug (2).

2 Remove two nuts (3), two washers (4), two screws (5) and dimmer switch (1).

3 To remove stoplight switch (6), disconnect two electrical connectors (7).

4 Remove two nuts (8), two washers (9), two screws (10) and stoplight switch (6).

b. Installation

Install stoplight switches and headlight dimmer in reverse order of removal.

c. Adjustment

Adjust stoplight switch by loosening setscrew (11) and stoplight actuator (12). Slide actuator right or left so that stoplight goes on when brake pedal (13) is depressed approximately 3/4 inch (19-mm). Tighten setscrew (11).

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

8-30.1. SLAVE START RECEPTACLE

This task covers:

a. Removal b. Installation

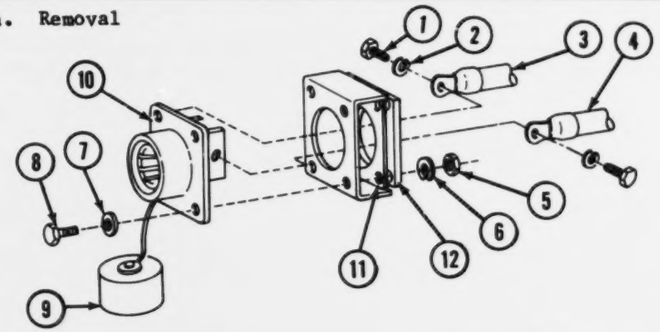
NOTE

The M109A2/M109A3 NATO slave receptacle is located in the bulkhead, and the M109A4 NATO slave receptacle is located in the driver's compartment.

INITIAL SET-UP

Materials/parts
Electrical tape-black (as required)

a. Removal



1 Disconnect batteries (ref. p. 8-55).

2 Cut away electrical tape and remove two screws (1) and two lockwashers (2) to disconnect power (3) and ground leads (4).

3 Remove four nuts (5), four lockwashers (6), four flatwashers (7) and four screws (8).

4 Remove protective cover (9) from receptacle assembly (10).

5 Remove slave start receptacle assembly (10), gasket (11) and insulator (12).

b. Installation

1 Install in reverse order to removal.

2 Ensure that protective cover (9) cord is attached under one screw (8).

3 Wrap exposed wire connections with electrical tape (as required).

8-30.2. EXTERNAL POWER RECEPTACLE - M109A4

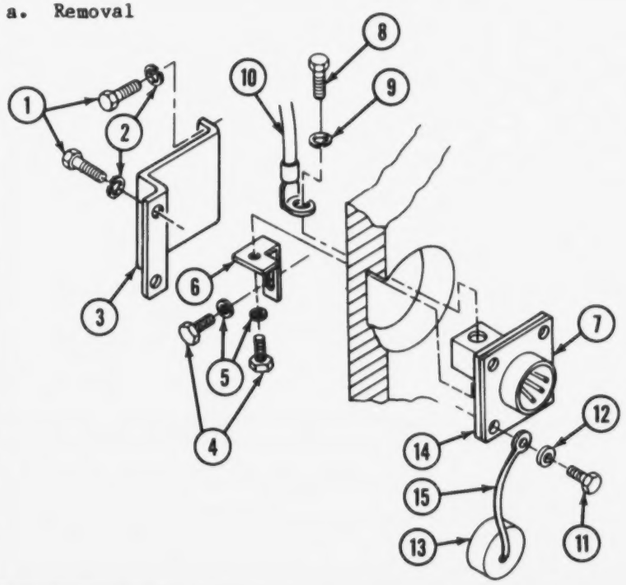
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/parts
Electrical tape-black (as required)

a. Removal



1 Disconnect batteries (ref. p. 8-55).

2 Remove four screws (1), four lockwashers (2) and guard assembly (3).

3 Remove two screws (4), two lockwashers (5), and bus bar (6) from receptacle assembly (7).

4 Remove screw (8) and lockwasher (9) to disconnect cable (10).

5 Remove four screws (11), four flatwashers (12) and protective cover (13) from receptacle assembly (7).

6 Remove external power receptacle (7) and gasket (14).

ELECTRICAL SYSTEMS - SECTION II. HULL ELECTRICAL SYSTEMS - CONTINUED

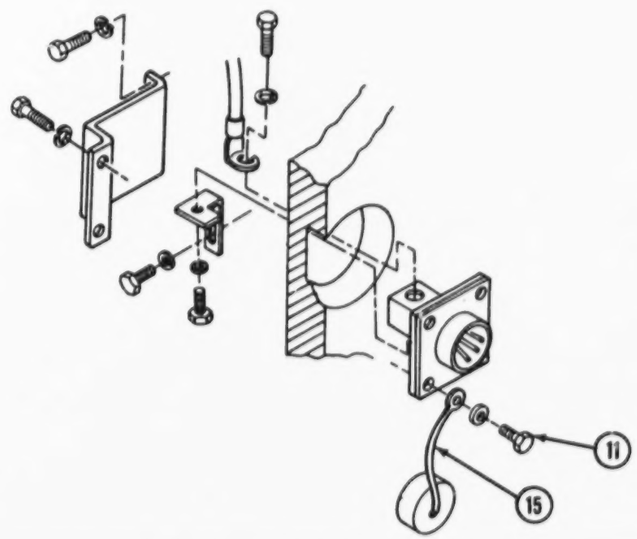
8-30.2. EXTERNAL POWER RECEPTACLE - M109A4 - CONTINUED

b. Installation

1 Install in reverse order of removal.

2 Ensure that protective cover cord (15) is attached under one screw (11).

3 Wrap exposed wire connections with electrical tape (as required).

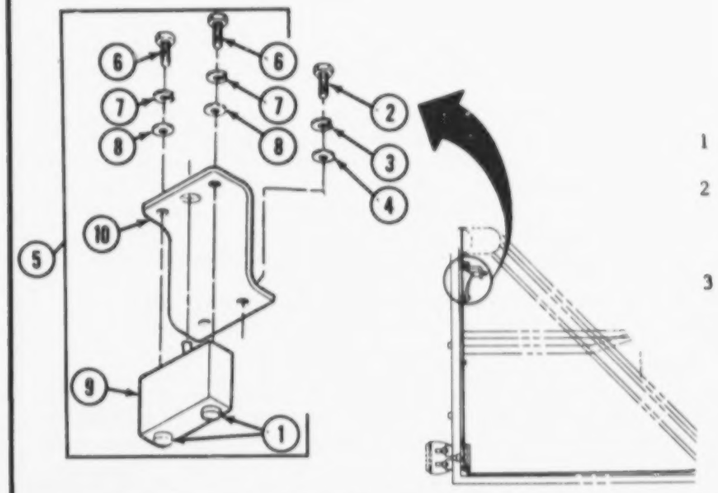


8-30.3. COMBAT OVERRIDE SWITCH ASSEMBLY - M109A4

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Be certain MASTER switch is OFF when working on starter protection override switch to avoid electrical shocks and burns.

1 Disconnect two electrical connectors (1).

2 Remove two screws (2), two lockwashers (3), two washers (4) and combat override switch assembly (5).

3 To disassemble switch assembly (5), remove two screws (6), two lockwashers (7), two washers (8) and switch (9) from bracket (10).

b. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES

This section provides instructions for removal of powerplant and hull wiring harnesses. Instructions for test, disassembly, and assembly of individual wiring harnesses are contained in Chapters 2 and 3 of this manual.

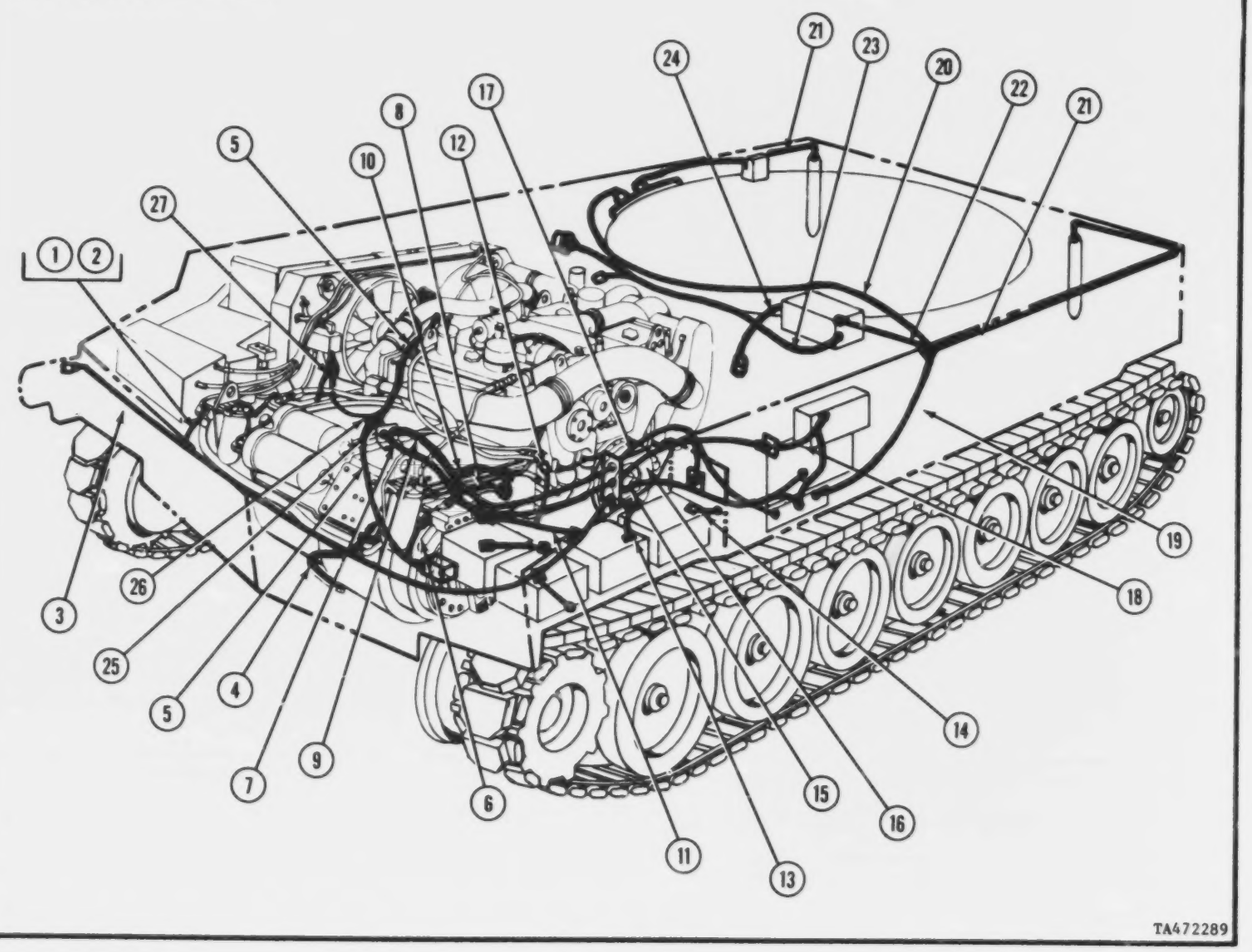
Each electrical cable is marked with a wire numbered metal tag attached to the junction of terminal of the cable. All electrical circuits shown in schematics and wiring diagrams are identified by wire numbers listed in each area.

NOTE

Refer to Task Sheets in this section, and Appendix D and specific troubleshooting pages for detailed routing of wiring harness. Refer to p. 2-23 for electrical repair kit data.

1. Wire 452 - Bilge pump relay to bilge pump
2. Wire 29-31 - To fuel level transmitters
   Wires 76 - To fuel tank fuel pumps
3. Harness 10921380 - To headlight assemblies
4. Ground wire - Powerplant to hull
5. Harness 12268102 - Alternator to rectifier
6. Harness 11593806 - Rectifier to voltage regulator
7. Harness 12268100 - Engine instrumentation bulkhead connector to powerplant connector bracket
8. Wire 27B - From harness 12268100 to voltage regulator
9. Wire 82/49 - Engine starter from lower powerplant connector bracket to bulkhead connector
10. Wire 82 - From master relay to wire 82/49
11. Wire 81 - From batteries to master relay
12. Wire 2 - From voltage regulator to wire 81
13. Wire 68 - Battery positive to negative connectors
14. Wire 7 - Battery to ground
15. Harness 11594268 - Bulkhead connector to driver's instrument panel
16. Harness 12260287 - Bulkhead connector to driver's compartment connector bracket
17. Lead 11593784 or 12260266 - From bulkhead connector to slave receptacle (wire 49) and to circuit breaker panel (wire 10)
18. Harness 12260298 - From driver's compartment/connector to portable instrument panel
19. Lead 11593784 or 12260266 - From circuit breaker to:
20. Slip ring segment board (47)
21. Telephone terminals (21, 22)
22. Accessory control box (37, 38)
23. Harness 10925829 - From accessory control box to heater fuel pump and personnel 10. heater
24. Harness 10925829 - From accessory control box to air cleaner blower assembly
25. Harness 12268102 - From bulkhead connector to engine instrumentation
26. Wire 82 - From bulkhead connector to engine starter
27. Wire 352A and 352B - From harness 12268102 to aeration detector

HULL ELECTRICAL HARNESS



TA472289

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

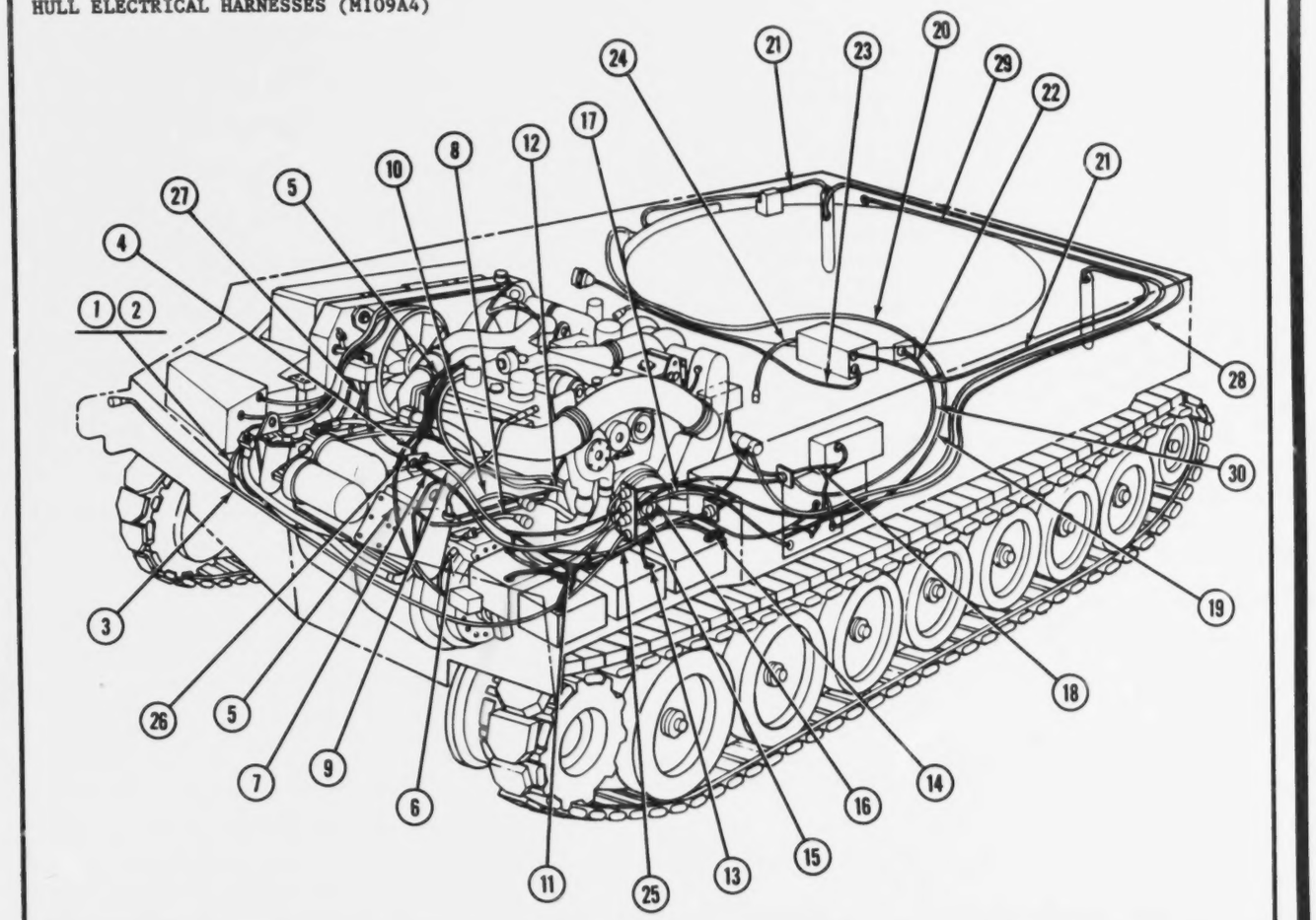
8-30.4. CIRCUIT IDENTIFICATION AND ILLUSTRATION OF ELECTRICAL HARNESSES - M109A4

NOTE

Each electrical cable is marked with a wire numbered metal tag attached to the junction of terminal of the cable. All electrical circuits shown in schematics and wiring diagrams are identified by wire numbers listed in each area.

1. Wire 452 - Bilge pump relay to bilge pump
2. Wire 29-31 - To fuel level transmitters
   Wires 76 - To fuel tank fuel pumps
3. Harness 10921380 - To headlight assemblies
4. Starter to engine electrical disconnect - harness 12353072
5. Harness 12268308 - Alternator to rectifier
6. Harness 12268303 - Rectifier to voltage regulator
7. Harness 12268418 - Engine instrumentation bulkhead connector to powerplant conector bracket
8. Wire 27B - From harness 12268418 - Engine instrumentation bulkhead connector to powerplant connector bracket
9. Harness 12353401 - Engine disconnect bracket to batteries lead assembly
10. Wire 82 - From master relay to wire 82/49
11. Wire 81 - From batteries to master relay
12. Wire 2 - From voltage regulator to wire 81
13. Wire 68 - Battery positive to negative connectors
14. Wire 7 - Battery to ground
15. Harness 11594268 - bulkhead connector to driver's instrument panel
16. Harness 12260287 - Bulkhead connector to driver's compartment connector bracket
17. Lead 12268304 - From bulkhead connector to slave receptacle (wire 49) and to circuit breaker panel (wire 10)
18. Harness 12260298 - From driver's compartment/connector to portable instrument panel
19. Lead 12268304 - From circuit breaker to:
    20. Slip ring segment board (47)
    21. Telephone terminals (21, 22)
    22. Accessory control box (37, 38)
23. Harness 10925829 - From accessory control box to heater fuel pump and personnel heater
24. Harness 12268308 - From bulkhead connector to engine instrumentation
25. Harness 12353402 - Driver's bulkhead to batteries wiring harness
26. Wire 82 - From bulkhead connector to engine starter
27. Wire 352A and 352B - From harness to aeration detector
28. Harness 12353400 - NATO slave to external power receptacle wiring harness
29. Lead 12268419 - Bulkhead to override switch lead
30. Harness 12352794 - Ventilated face piece system wiring harness

HULL ELECTRICAL HARNESSES (M109A4)



ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-31. POWERPLANT WIRING HARNESS (12268102)

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

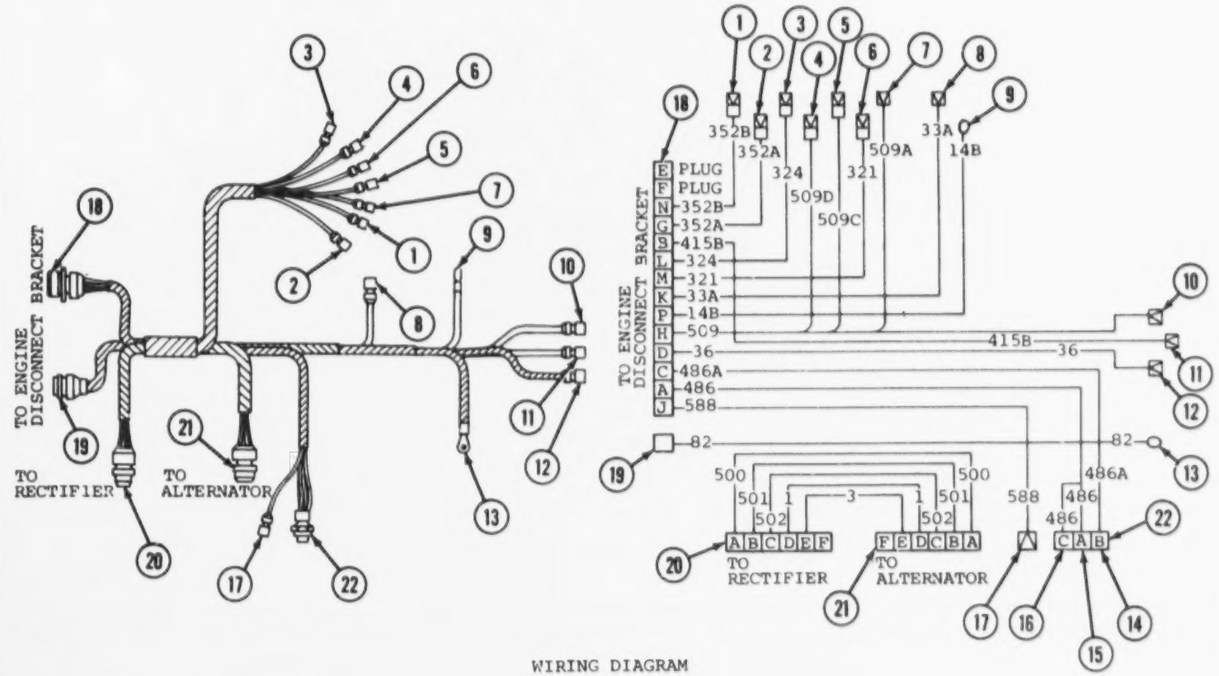
Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Low Level Coolant Indicator	352B
2.	Low Level Coolant Indicator	352A
3.	Transmission Oil Temperature Transmitter	324
4.	Transmission Oil High Temperature Switch	509D
5.	Transmission Oil Low Pressure Switch	509C
6.	Transmission Oil Pressure Transmitter	321
7.	Engine Coolant High Temperature Switch	509A
8.	Engine Coolant Temperature Transmitter	33A
9.	Starter Motor Solenoid from Starter Relay	14B
10.	Engine Oil Low Pressure Switch	509B
11.	Air Cleaner Blower Motor Switch	415B
12.	Engine Oil Pressure Transmitter	36
13.	Starter Motor Solenoid from Master Relay	82
14.	Flame Heater ignition Coil	486
15.	Flame Heater Air Pump	486
16.	Flame Heater Solenoid	486A
17.	Fuel Prime Pump	588
18.	Master Circuit Harness	1226810
19.	Starter Cable Connector	82
20.	Rectifier Connector 500, 501, 502,	1 and 3
21.	Alternator Connector 500, 501, 502,	1 and 3
22.	Flame Heater Connector	

POWERPLANT ELECTRICAL HARNESS (12268102)

NOTE

Harness P/N 12268102 is used only on M109A2/M109A3 vehicles.



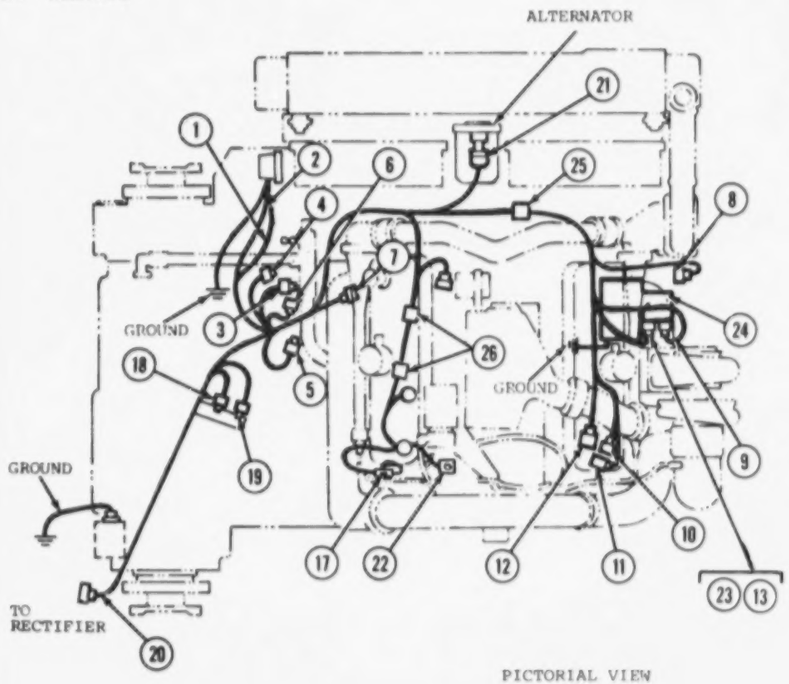
WIRING DIAGRAM

TA472290

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-31. POWERPLANT WIRING HARNESS (12268102) - CONTINUED

a. Removal



PICTORIAL VIEW

WARNING

Be certain MASTER switch is OFF when working on hull electrical system to avoid electrical shocks or burns.

1 Open air intake grille (ref. p. 11-22).

2 Open transmission access doors (ref p. 4-9).

3 Remove driver's access door located in driver's compartment (ref. p. 11-20).

4 Disconnect five connectors (18), (19), (20), (21) and (22).

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NOTE

- Flame heater system connectors (14), (15), and (16) are not part of harness 12268102.
- Access to wires 10 through 12 will be through driver's compartment.
- Powerplant must be removed to remove starter leads (9) and (13) (ref. Chapter 4).

5 Disconnect 12 connectors, (1 thru 8), (10 thru 12) and (17).

6 Remove two nuts (23) and two flatwashers (24). Remove leads (9) and (13) at starter solenoid (25).

7 Remove two screws (26) and two clamps (27). Remove two screws (28) and two clamps (29). Place four screws back into engine.

8 Remove powerplant wiring harness.

b. Disassembly

1 Remove electrical tape where necessary for disassembly.

2 Isolate and separate wiring harness branches.

3 Disassemble wiring branch (ref. p. 2-23) of wires to be replaced.

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-31.1. POWERPLANT WIRING HARNESS (12268308) - M109A4

This task covers:

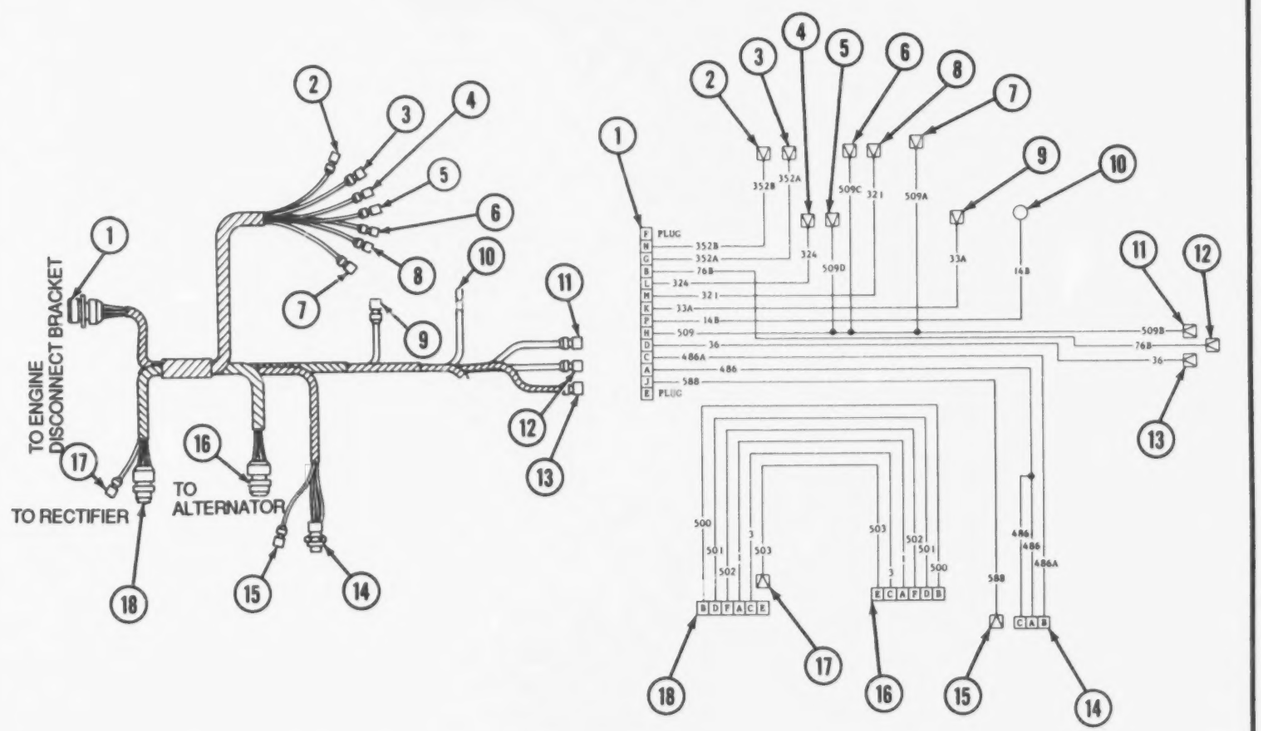
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Engine Disconnect Bracket	
2.	Low Level Coolant Indicator	352B
3.	Low Level Coolant Indicator	352A
4.	Transmission Oil Temperature Transmitter	324
5.	Transmission Oil Temperature Switch	509D
6.	Transmission Oil Pressure Switch	509C
7.	Engine Coolant Temperature Switch	509A
8.	Tramsmission Oil Pressure Transmitter	321
9.	Engine Coolant Temperature Transmitter	33A
10.	Starter Solenoid Coil	14B
11.	Engine Oil Pressure Switch	509B
12.	In-take Fuel Pump and Generator System Relay Switch	76B
13.	Engine Oil Pressure Transmitter	36
14.	Flame Heater System Connector	
15.	Fuel Prime Pump	588
16.	Alternator	
17.	Starter Protection Relay	503
18.	To Rectifier	

POWERPLANT ELECTRICAL HARNESS (12268308)

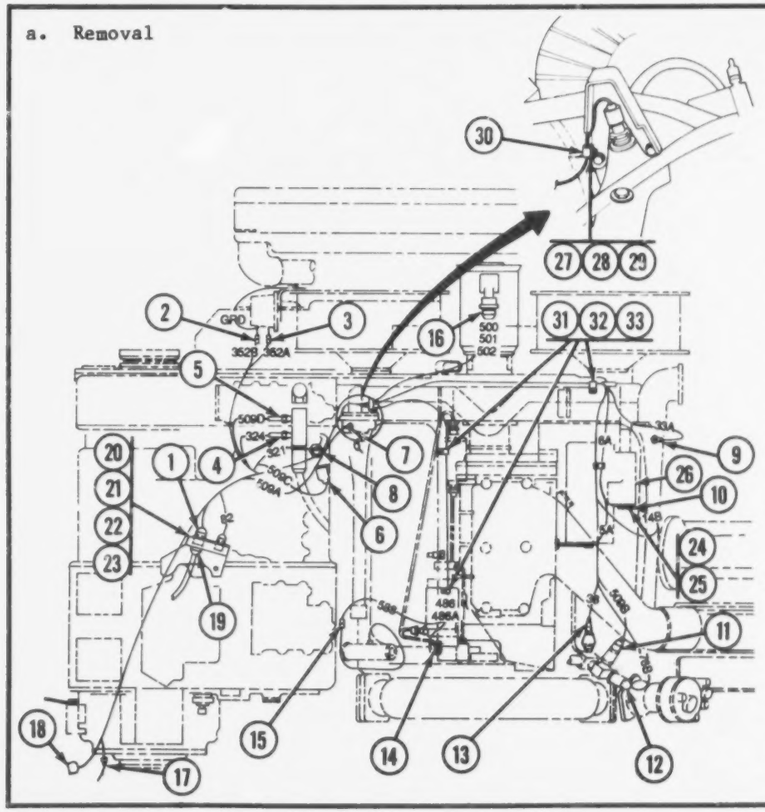


WIRING DIAGRAM

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-31.1. POWERPLANT WIRING HARNESS (12268308) - M109A4 - CONTINUED

a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical system to avoid electrical shocks or burns.

1 Open air intake grille (ref. p. 11-21).

2 Open transmission access doors (ref. p. 4-9).

3 Remove engine access cover located in driver's compartment (ref. p. 11-20).

4 Disconnect driver's bulkhead to master relay wiring harness (19) at engine disconnect bracket.

5 Remove four nuts (20), four lockwashers (21), four washers (22) and four screws (23).

6 Remove connector (1) from engine disconnect bracket.

7 Disconnect electrical connectors (17) and (18).

NOTE

Access to wires 11 through 13 will be through driver's compartment.

Powerplant must be removed to remove starter lead (10) (ref. Chapter 4).

8. Disconnect 14 electrical connectors (2 through 9, 11 through 16).

9. Remove nut (24) and flatwasher (25). Remove lead (10) at starter solenoid (26).

10. Remove two screws (27), two washers (28), two nuts (29) and two clamps (30). Remove four screws (31), four lockwashers (32) and four clamps (33). Place four screws (31) back into engine.

11. Remove powerplant wiring harness.

b. Disassembly/Repair

1 Remove electrical tape where necessary for disassembly.

2 Isolate and separate wiring harness branches.

3 Disassemble wiring branch (ref. p. 2-23) of wires to be replaced.

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-32. ENGINE DISCONNECT BRACKET TO BULKHEAD WIRING HARNESS (12268100)

This task covers:

a. Disassembly/Repair b. Assembly

INITIAL SET-UP

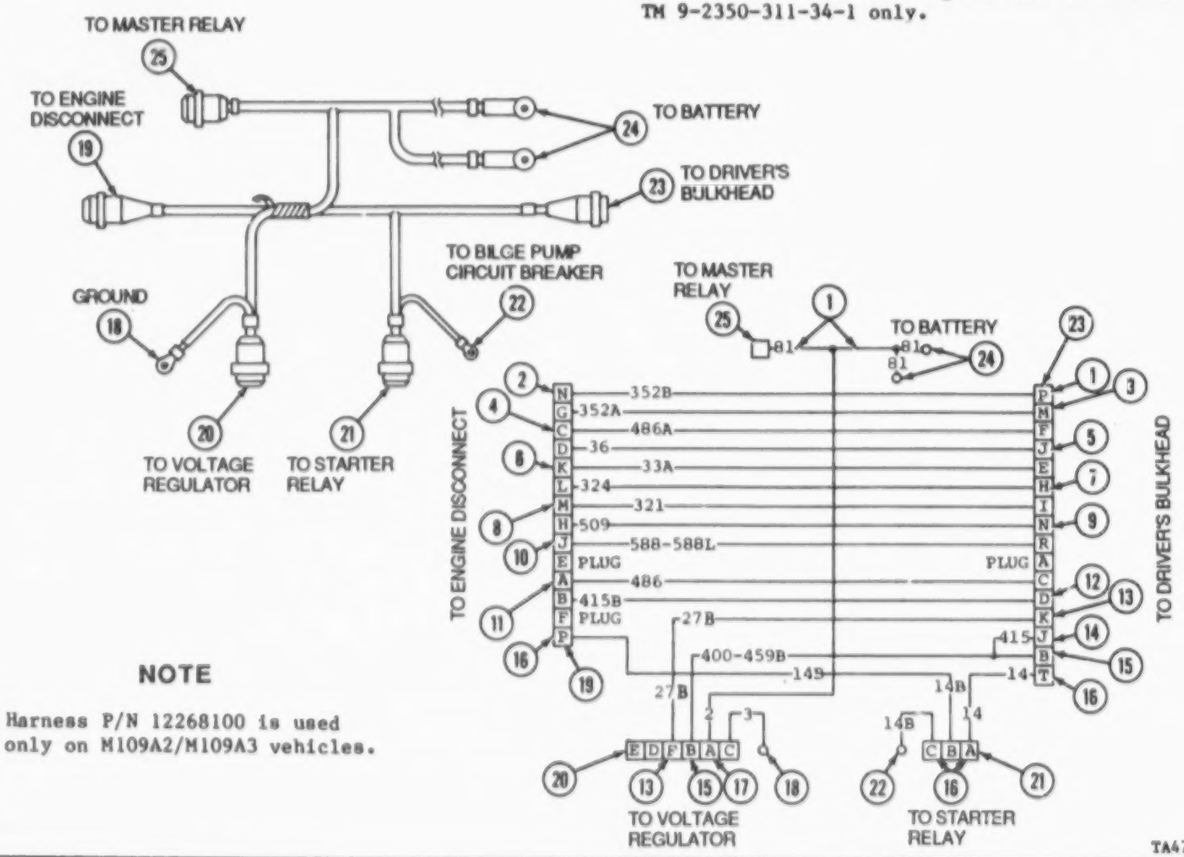
Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Battery Assembly to Master Relay	81
2.	Aeration Detector to Coolant Indicator	352B
3.	Aeration Detector to Coolant Indicator	352A
4.	Flame Heater to Flame heater Switch	486A
5.	Engine Oil Pressure Transmitter to Engine Oil Pressure Gage Switch	36
6.	Engine Coolant Temperature Transmitter to Engine Water Temperature Gage	33A
7.	Transmission Oil Temperature Transmitter to Transmission Oil Temperature Gage	324
8.	Transmission Oil Pressure Transmitter to Transmission Oil Pressure Switch	321
9.	High/Low Temperature and Pressure Switches/Transmitters to Master Warning Light	509
10.	Air Cleaner Blower Motor Switch to Air Cleaner Blower Motor Assembly	415B
11.	Regulator Cutoff relay Coil Energizer	27B
12.	Air Cleaner Blower Motor Circuit	415
13.	Master Switch Voltage Regulator Lead	400-459B
14.	Engine Starter Circuit (Starter Relay Bilge Pump Circuit Breaker Neutral Safety Switch)	14/14B
15.	Voltage Regulator to Master Relay Lead	2
16.	Ground Wire	3
17.	Engine Bracket Disconnect Connector	
18.	Voltage Regulator Connector	
19.	Starter Relay Connector	
20.	Bilge Pump Circuit Breaker Lead	
21.	Driver's Bulkhead Connector	
22.	Battery Connectors	
23.	Master Relay Connectors	

10. Fuel Prime Pump to Fuel Prime Pump Switch 588
11. Flame Heater Motor Pump to Flame Heater Switch 486

NOTE

Removal and installation of the engine disconnect bracket to bulkhead wiring harness is covered in TM 9-2350-311-34-1 only.



NOTE

Harness P/N 12268100 is used only on M109A2/M109A3 vehicles.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-32. ENGINE DISCONNECT BRACKET TO BULKHEAD WIRING HARNESS (12268100) - CONTINUED

a. Disassembly/Repair

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shocks and burns.

1 Remove electrical tape for only the sections to be disassembled.

2 Separate/isolate harness branches.

3 Disassemble harness branch (ref. p. 2-23).

b. Assembly

Assemble in reverse order of disassembly (ref. p. 2-23).

8-32.1. DRIVER'S BULKHEAD TO MASTER RELAY WIRING HARNESS (12268418) - M109A4

This task covers:

a. Disassembly/Repair b. Assembly

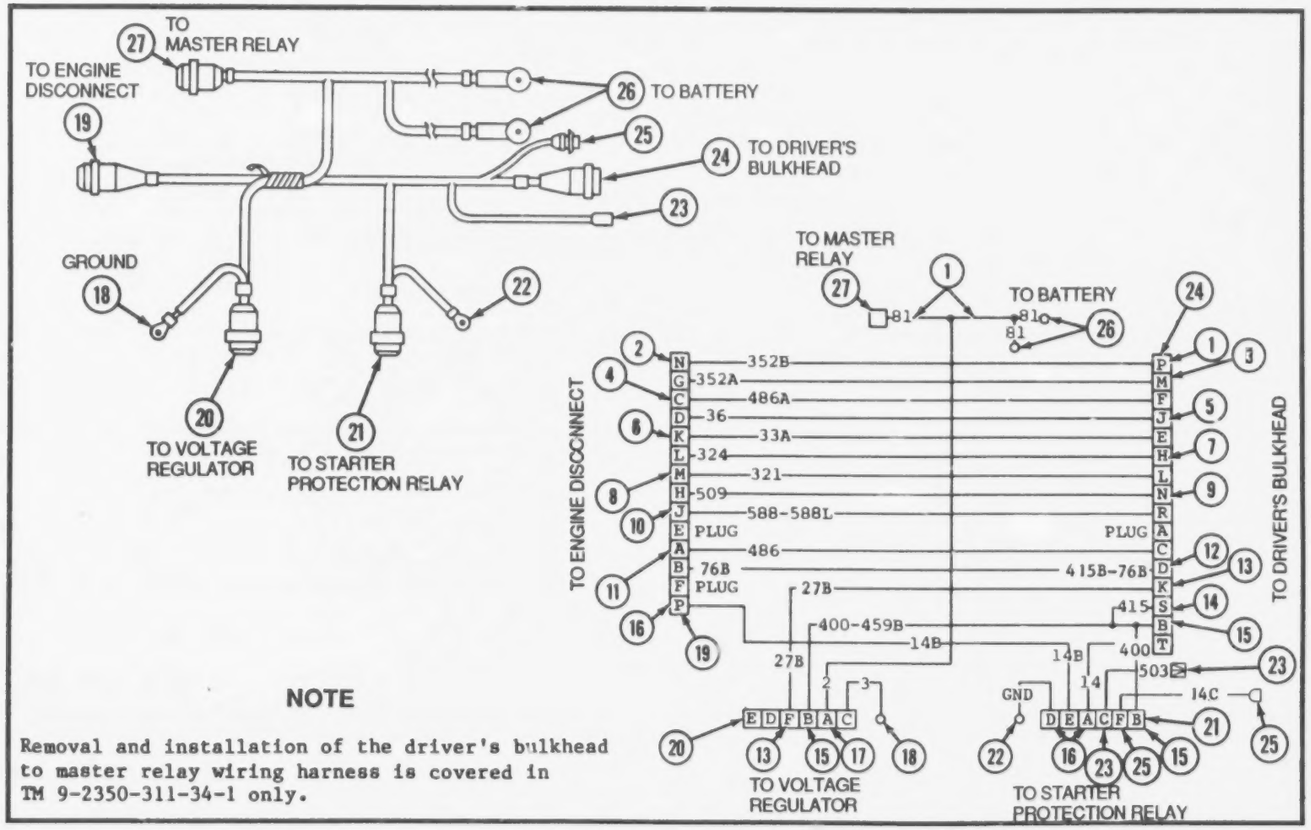
INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Battery Assembly to Master Relay	81
2.	Aeration Detector to Coolant Indicator	352B
3.	Aeration Detector to Coolant Indicator	352A
4.	Flame Heater to Flame heater Switch	486A
5.	Engine Oil Pressure Transmitter to Engine Oil Pressure Gage Switch	36
6.	Engine Coolant Temperature Transmitter to Engine Water Temperature Gage	33A
7.	Transmission Oil Temperature Transmitter to Transmission Oil Temperature Gage	324
8.	Transmission Oil Pressure Transmitter to Transmission Oil Pressure Switch	321
9.	High/Low Temperature and Pressure Switches/Transmitters to Master Warning Light	509
10.	Air Cleaner Blower Motor Switch to Air Cleaner Blower Motor Assembly	415B-76B
11.	Regulator Cutoff relay Coil Energizer	27B
12.	Air Cleaner Blower Motor Circuit	415
13.	Master Switch Voltage Regulator Lead	400-459B
14.	Engine Starter Circuit (Starter Relay Bilge Pump Circuit Breaker Neutral Safety Switch)	14/14B/GND
15.	Voltage Regulator to Master Relay Lead	2
16.	Ground Wire	3
17.	Engine Bracket Disconnect Connector	
18.	Voltage Regulator Connector	
19.	Starter Protection Relay Connector	
20.	Starter Protection Relay Ground	
21.	Alternator Circuit	503
22.	Driver's Bulkhead Connector	
23.	Drivers bulkhead connector to Starter Protection Relay	14C
24.	Battery Connectors	
25.	Master Relay Connector	

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-32.1. DRIVER'S BULKHEAD TO MASTER RELAY WIRING HARNESS (12268418) -M109A4 - CONTINUED



NOTE

Removal and installation of the driver's bulkhead to master relay wiring harness is covered in TM 9-2350-311-34-1 only.

8-32.1. DRIVER'S BULKHEAD TO MASTER RELAY WIRING HARNESS (12268418) -M109A4 - CONTINUED

a. Disassembly/Repair

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shocks and burns.

1 Remove electrical tape for only the sections to be disassembled.

2 Separate/isolate harness branches.

3 Disassemble harness branch (ref. p. 2-23).

b. Assembly

Assemble in reverse order of disassembly (ref. p. 2-23).

8-33. BULKHEAD TO HEADLIGHTS/BILGE PUMP WIRING HARNESS (10921380)

This task covers:

a. Disassembly b. Assembly

INITIAL SET-UP

Materials/Parts
Electrical tape - black
(as required)

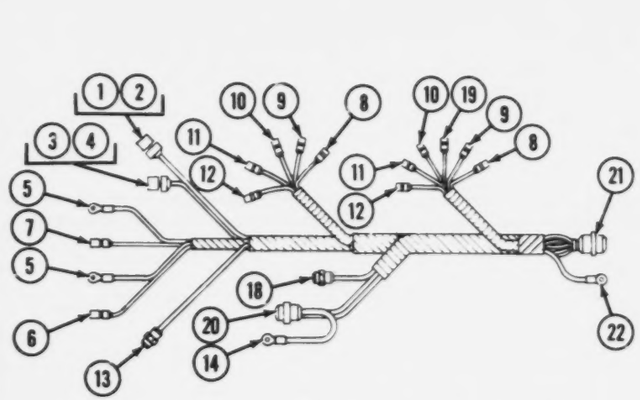
Connector Number	Location/Function	Wire No.	Connector Number	Location/Function	Wire No.
1.	Left fuel pump lead	76	12.	Service headlight high beam	17
2.	Left fuel pump	Ground	13.	Bilge pump motor connector	452
3.	Right fuel pump	Ground	14.	Master relay connector	459
4.	Right fuel pump lead	76	15.	Bilge pump relay lead	452
5.	Right upper and lower fuel tank	Ground	16.	Bilge pump relay energizing circuit	450
6.	Right upper fuel tank transmitter lead	29	17.	Bilge pump relay power lead	452B
7.	Right lower fuel tank transmitter lead	31	18.	Bilge pump circuit breaker connector	452B
8.	Service blackout IR lower beam	515	19.	BO-IR drive light lead	19
9.	Service blackout IR upper beam	514	20.	Bilge pump relay connector	
10.	Blackout marker (front light assembly)	20	21.	Bulkhead connector	
11.	Service headlight low beam	18	22.	Ground	

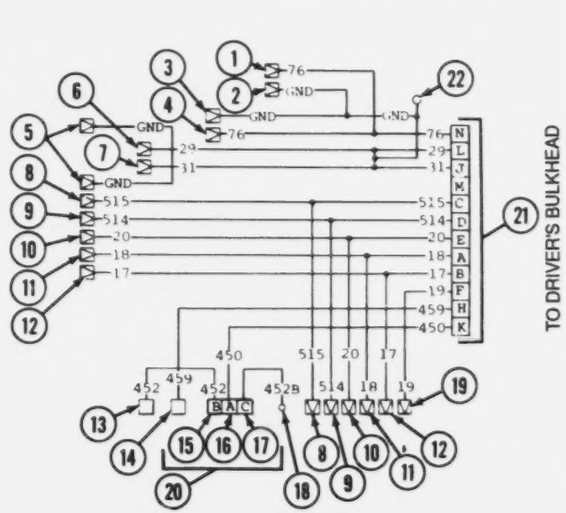
ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-33. BULKHEAD TO HEADLIGHTS/BILGE PUMP WIRING HARNESS (10921380) - CONTINUED

NOTE

Removal and installation of the bulkhead to headlights/bilge pump wiring harness is covered in TM 9-2350-311-34-1 only.





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TA472293

a. Disassembly

1 Remove electrical tape for only the sections to be disassembled.

2 Separate/isolate harness branches.

3 Disassemble harness branch (see p. 2-23).

b. Assembly

Assemble in reverse order of disassembly (ref. p. 2-23).

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-34. HEADLIGHT RESILIENT MOUNT WIRING HARNESS (10922308)

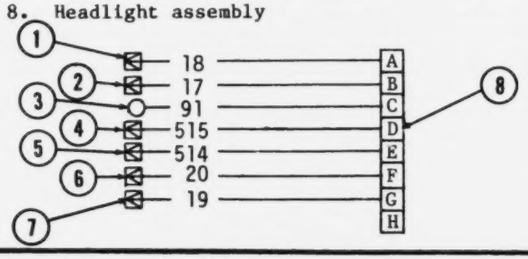
This task covers:

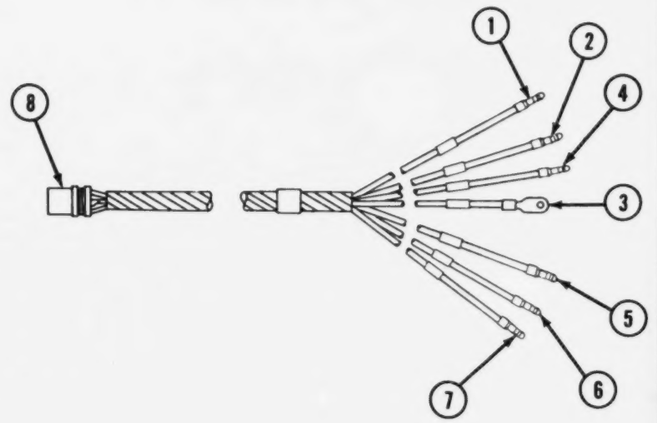
a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

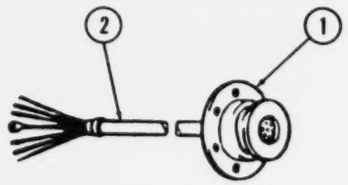
Connector Number	Electrical Lead To	Wire No.
1.	Harness P/N 10921380 - Wire 18	18
2.	Harness P/N 10921380 - Wire 17	17
3.	Harness P/N 10921380 - Wire 91	91
4.	Harness P/N 10921380 - Wire 515	515
5.	Harness P/N 10921380 - Wire 514	514
6.	Harness P/N 10921380 - Wire 20	20
7.	Harness P/N 10921380 - Wire 19	19
8.	Headlight assembly	





TA472294

a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shocks and burns.

1 Remove mount assembly (ref. p. 8-46).

2 Separate mount (1) from harness (2).

b. Installation

Install in reverse order of removal.

TA472295

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-35. HEADLIGHT HARNESS ASSEMBLY (87744300)

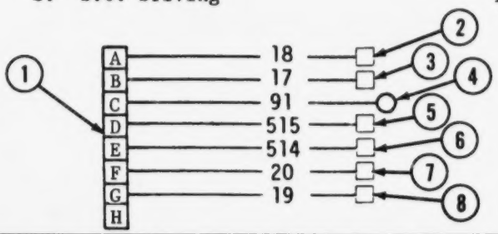
This task covers:

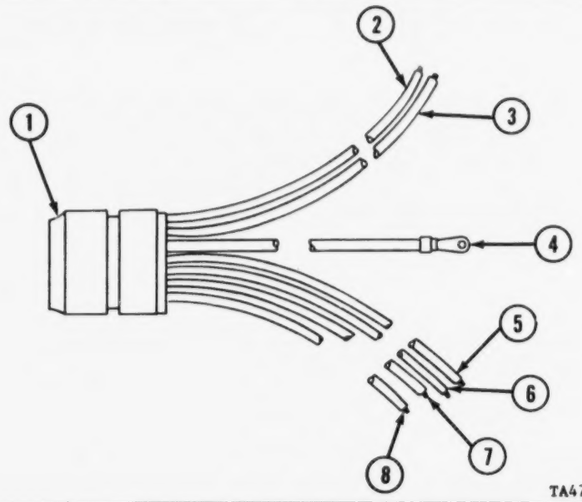
a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Headlight resilient mount	
2.	Low beam service	18
3.	High beam service	17
4.	Ground	91
5.	B.O. Low beam (IR)	515
6.	B.O. High beam (IR)	514
7.	B.O. Marker	20
8.	B.O. Driving	19





a. Removal

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shocks and burns.

For removal of the headlight harness assembly see the headlight mount disassembly instructions (ref. p. 8-46).

b. Installation

Install in the reverse order of removal.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-36. BULKHEAD TO PORTABLE INSTRUMENT PANEL WIRING HARNESS (12260287)

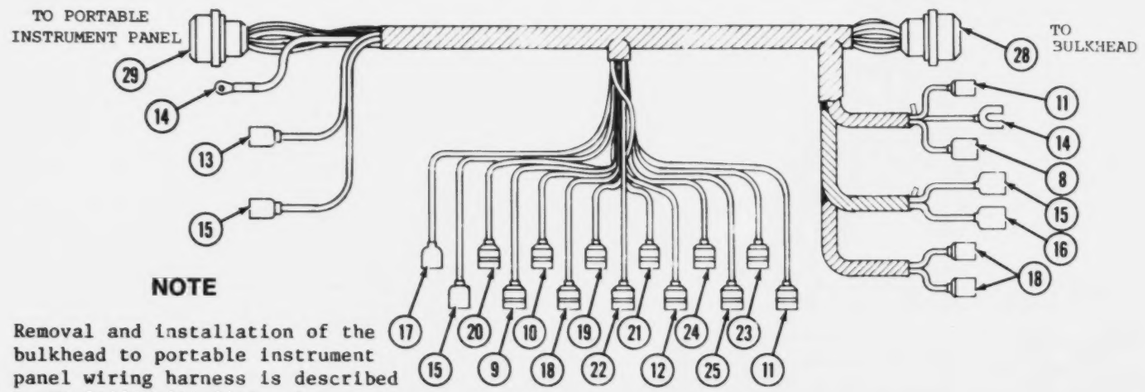
This task covers:

a. Disassembly b. Assembly

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Aeration detector	352B
2.	Aeration detector	352A
3.	Master switch	459B
4.	Engine oil pressure gage	36
5.	Engine water temperature gage	33A
6.	Transmission oil temperature gage	324
7.	Transmission oil pressure gage	321
8.	Warning lamp - switch	509
9.	Panel lights	40
10.	Fuel level gage and switch	29-31
11.	Engine instrument and master warning light	27
12.	Master switch	459A
13.	Master switch	459
14.	Ground	GND
15.	Parking brake warning switch and light	509E
16.	Parking brake warning light	509E
17.	Air cleaner blower motor relay	415B
18.	Starter switch - neutral safety switch	14
19.	Flame heater electrical lead	486A
20.	Connector to 415 air cleaner blower motor relay	27B
21.	Accessory control box	400
22.	Flame heater electrical lead	486
23.	Air cleaner blower assembly	415
24.	Fuel prime pump switch	588
25.	Fuel prime pump indicator lamp	588L
26.	Fuel prime pump	588-588L
27.	Voltage regulator	400-459B
28.	Bulkhead connector	
29.	Portable instrument connector	



NOTE

Removal and installation of the bulkhead to portable instrument panel wiring harness is described in TM 9-2350-311-34-1 only.

a. Disassembly

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shocks or burns.

1 Remove electrical tape for only the sections to be disassembled.

2 Separate/isolate harness branches.

3 Disassemble harness branch (ref. p. 2-23).

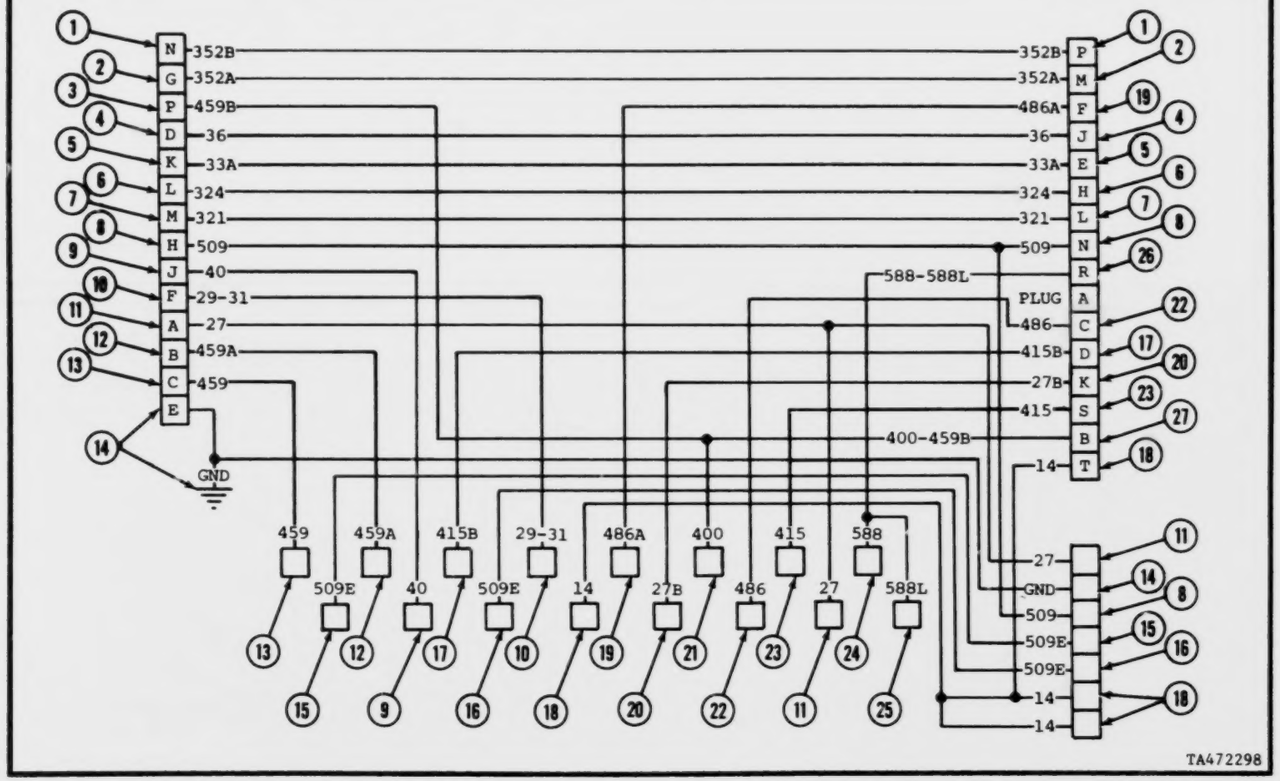
b. Assembly

Assemble in reverse order of disassembly.

TA472297

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-36. BULKHEAD TO PORTABLE INSTRUMENT PANEL WIRING HARNESS (12260287) - CONTINUED



8.37. BULKHEAD TO DRIVER'S INSTRUMENT PANEL WIRING HARNESS (11594268)

This task covers:

a. Disassembly b. Assembly

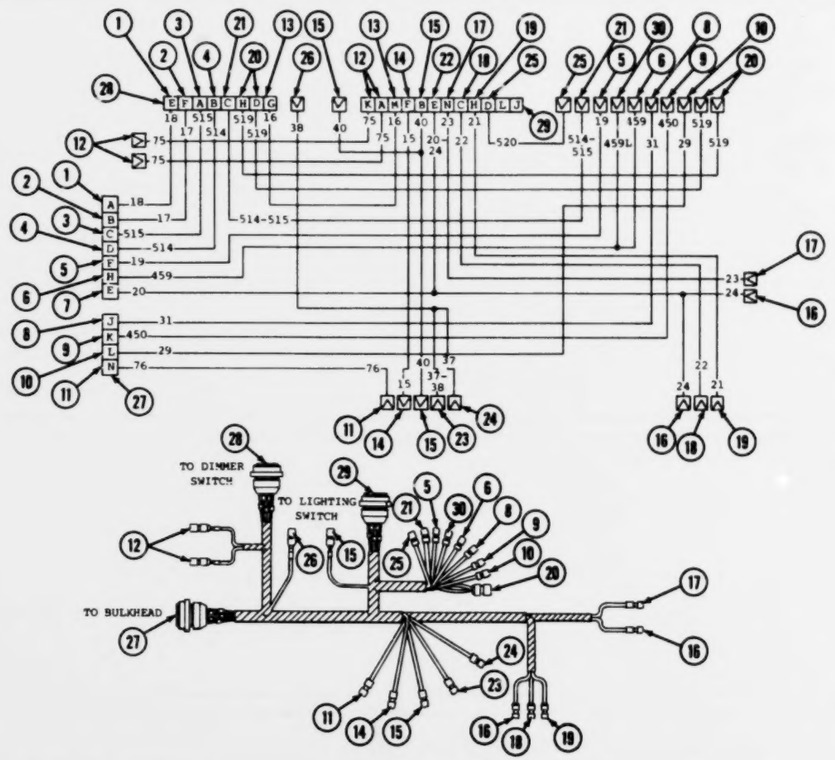
INITIAL SET-UP

Material/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Service headlight dimmer switch - low beam	18
2.	Service headlight dimmer switch - high beam	17
3.	Service blackout IR headlight - low beam	515
4.	Service blackout IR headlight - high beam	514
5.	Blackout/IR selector switch	19
6.	Master switch circuit	459
7.	Blackout marker light - front	20
8.	Fuel level switch - right lower tank	31
9.	Bilge pump switch - energizing circuit	450
10.	Fuel level switch - right upper tank	29
11.	Fuel pump circuit breaker	76
12.	Stop light switch - light switch	75
13.	Light switch - dimmer switch	16
14.	Main light switch power lead	15
15.	Main light switch - panel lights	40
16.	Main light switch - BO marker rear	24
17.	Main light switch - BO stop light	23
18.	Main light switch - service stop light	22
19.	Main light switch - service tail light	21
20.	High beam indicator light	519
21.	BO-IR selector switch - dimmer	514-515
22.	Light circuits	20-24
23.	Driver's dome light, auxiliary outlet and trailer receptacle	37-38
24.	Auxiliary outlet and trailer receptacle	37
25.	Light switch to BO-IR selector	520
26.	Driver's dome light	38
27.	Connector dimmer switch	
28.	Connector dimmer switch	
29.	Connector lighting switch	
30.	Master warning switch	459L

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8.37. BULKHEAD TO DRIVER'S INSTRUMENT PANEL WIRING HARNESS (11594268) - CONTINUED



TA472299

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock or burns.

NOTE

Removal and installation of the bulkhead to driver's instrument panel wiring harness is described in TM 9-2350-311-34-1 only.

a. Disassembly/Repair

1 Remove electrical tape as necessary for sections to be disassembled.

2 Separate/isolate wiring harnesses.

3 Disassemble wiring harness (see p. 2-23).

b. Assembly

Assemble in reverse order of disassembly.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-38. DRIVER'S INSTRUMENT PANEL WIRING HARNESS (12268104)

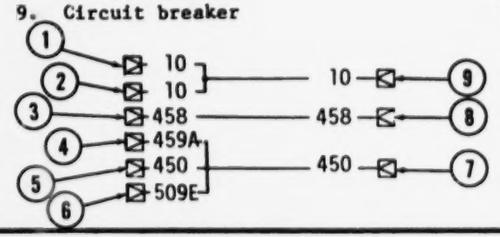
This task covers:

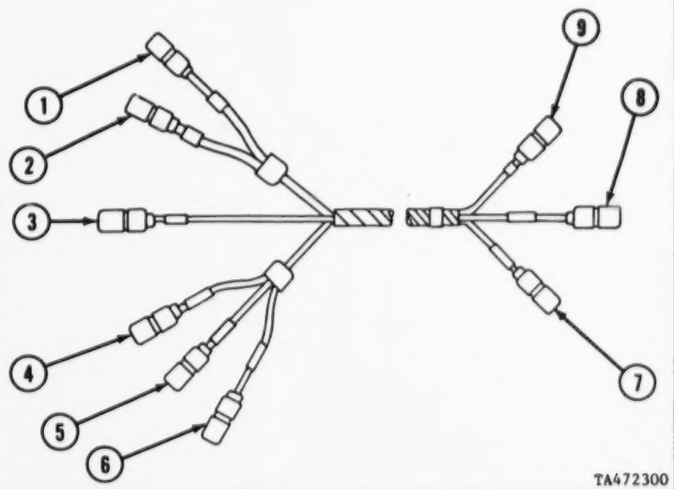
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	STARTER switch	10
2.	Flame heater switch	10
3.	Fuel prime switch	458
4.	Terminal 459A of harness 12260287	459A
5.	Bilge pump switch	450
6.	Parking brake warning light	509E
7.	Circuit breaker	450
8.	Circuit breaker	458
9.	Circuit breaker	10

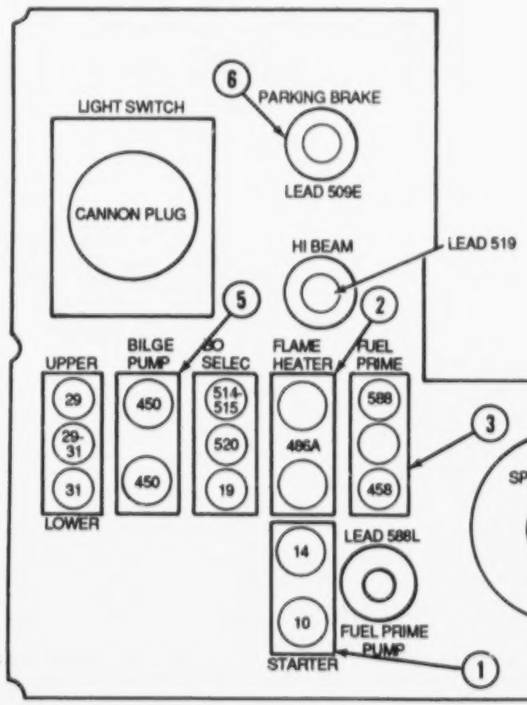




TA472300

a. Removal

DRIVER'S INSTRUMENT PANEL (REAR VIEW)



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connector wire 10 at STARTER switch (1).

4 Disconnect connector wire 10 at FLAME HEATER switch (2).

5 Disconnect connector wire 458 at FUEL PRIME switch (3).

6 Disconnect connector wire 450 at BILGE PUMP switch (5).

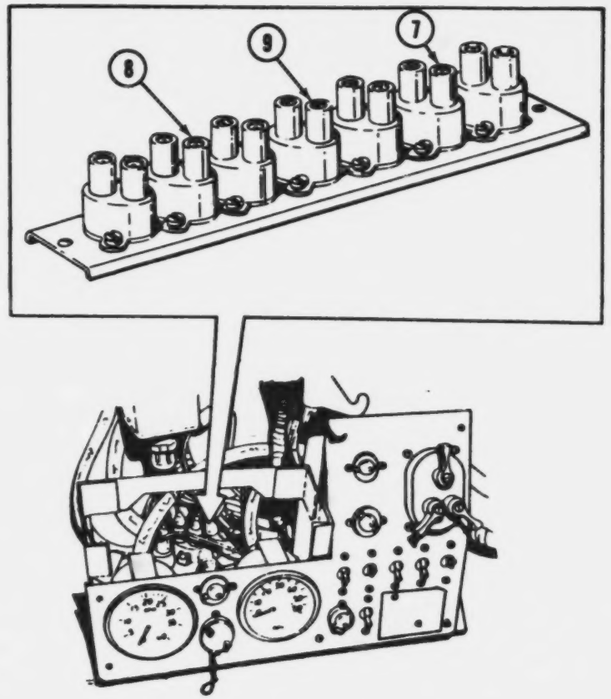
7 Disconnect connector wire 509E at PARKING BRAKE warning light lead (6).

TA472301

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-38. DRIVER'S INSTRUMENT PANEL WIRING HARNESS (12268104) - CONTINUED

a. Removal - Continued



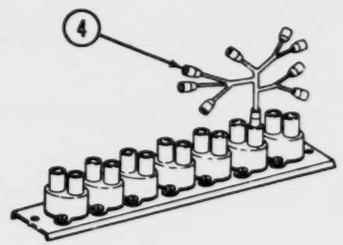
8 Disconnect connector wire 450 at circuit breaker (7).

9 Disconnect connector wire 458 at circuit breaker (8).

10 Disconnect connector wire 10 at circuit breaker (9).

TA472302

a. Removal - Continued



11 Disconnect connector wire 459A at harness P/N 12260287 (4).

b. Disassembly/Repair

Disassemble harness in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472303

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-39. ACCESSORY CONTROL BOX TO HEATER/BLOWER WIRING HARNESS (10925829)

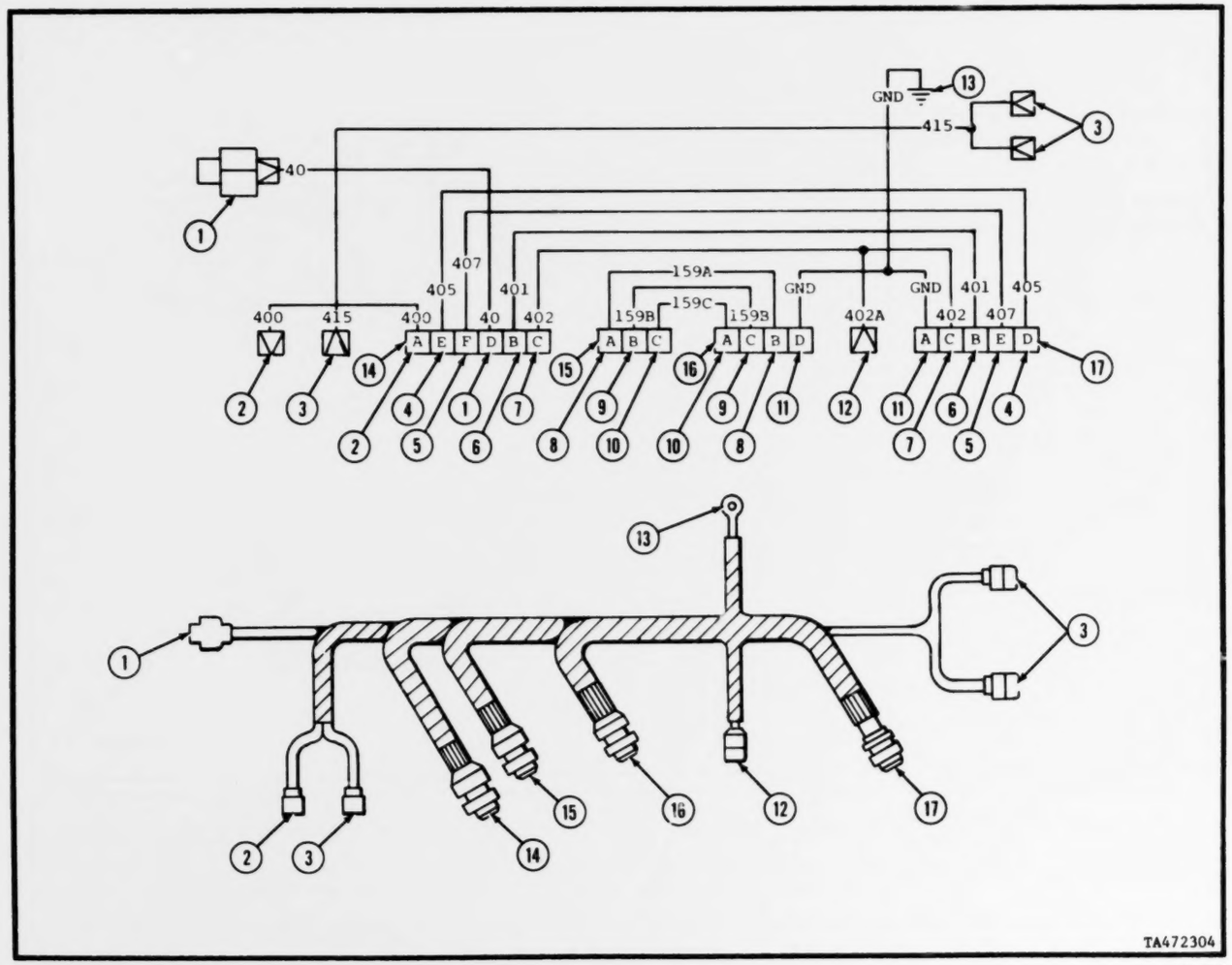
This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.	Connector Number	Electrical Lead To	Wire No.
1.	Panel lights	40	9.	Personnel vent fan	159B
2.	Personnel heater power circuit	400	10.	Personnel vent fan	159C
3.	Air cleaner blower motor	415	11.	Personnel vent fan	GND
4.	Personnel heater ignition circuit	405	12.	Personnel heater fuel pump	402A
5.	Personnel heater preheat resistor circuit	407	13.	Ground	GND
			14.	Connector accessory control box	
6.	Personnel heater fuel control valve circuit	401	15.	Connector accessory control box	
7.	Personnel heater fuel pump circuit	402	16.	Connector personnel vent fan	
8.	Personnel vent fan	159A	17.	Connector personnel heater	


GND
13
415
3
40
1
407
405
401
159A
159C
159B
GND
GND
401
405
400
415
400
40
402
159B
402A
402
407
A E F D B C
A B C
A C B D
A C B E D
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4
2
5
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10
10
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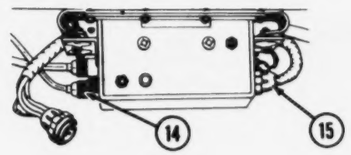
14

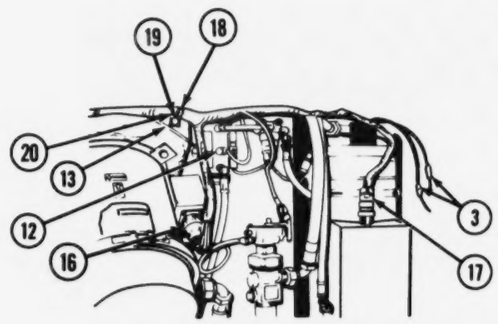
TA472304

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-39. ACCESSORY CONTROL BOX TO HEATER/BLOWER WIRING HARNESS (10925829) - CONTINUED

a. Removal





1 Disconnect batteries (ref. p.8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connectors (14) and (15) at accessory control box.

4 Disconnect connector (16) at personnel vent fan.

5 Disconnect connector (17) at personnel heater.

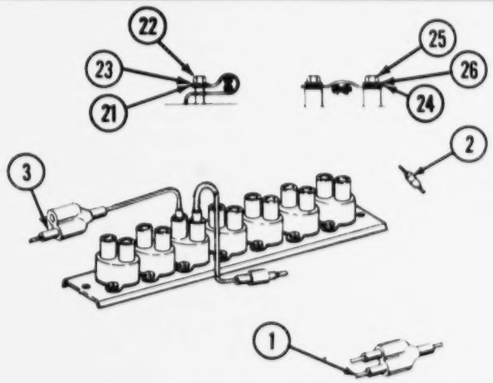
6 Disconnect connector wire 402A (12) at heater fuel pump.

7 Disconnect both connectors at air cleaner blower motors.

8 Remove screw (18), washer (19) and plastic attaching strap (20) to disconnect ground wire (13).

9 Release wiring harness 10925829 and reinstall plastic attaching strap assembly (20).

TA472305



10 Disconnect three connectors: wire 40 (1), wire 400 (2) and wire 415 (3) at the well behind driver's instrument panel.

NOTE

Release harness 10925829 and reinstall strap assemblies for steps 11 and 12.

11 Remove nine plastic attaching straps (21), nine screws (22) and nine washers (23).

12 Remove two plastic attaching straps (24), four screws (25) and four washers (26).

b. Disassembly/Repair

1 Remove electrical tape as necessary for sections to be disassembled.

2 Separate/isolate harness branches.

3 Disassemble harness branch in accordance with chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472306

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-40. ACCESSORY CONTROL BOX WIRING HARNESS (10925417)

This task covers:

a. Removal b. Installation

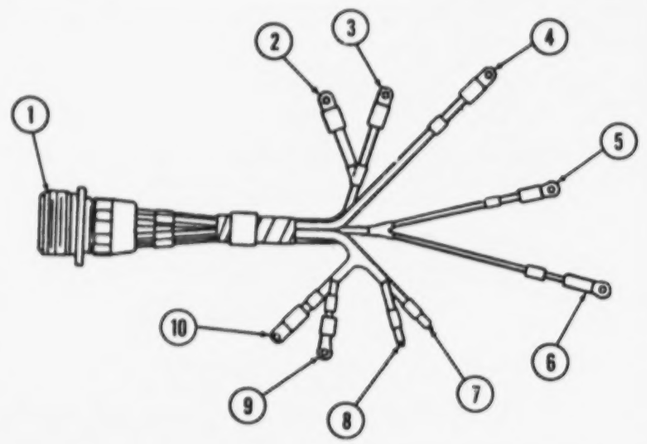
INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

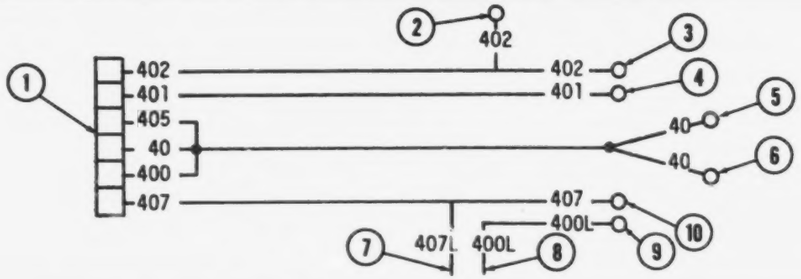
Connector Number	Electrical Lead To	Wire No.
1.	Accessory control box to heater/ blower wiring harness (10925829)	
2.	Heat selector switch	402
3.	Heat selector switch	402
4.	Heat selector switch	401
5.	Panel light	40
6.	Panel light	40
7.	Indicator light	407L
8.	Indicator light	400L
9.	Heat selector switch	400L
10.	Heat selector switch	407

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock or burns.



TA472307



a. Removal

For removal of the accessory control box wiring harness, reference the accessory control box repair (ref. p. 8-32).

b. Deleted

c. Deleted

d. Installation

For installation of the accessory control box wiring harness, reference the accessory control box repair (ref. p. 8-32).

A472308

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-41. POWER LEAD WIRING HARNESS (11593784)

This task covers:

a. Disassembly/Repair b. Assembly

INITIAL SET-UP

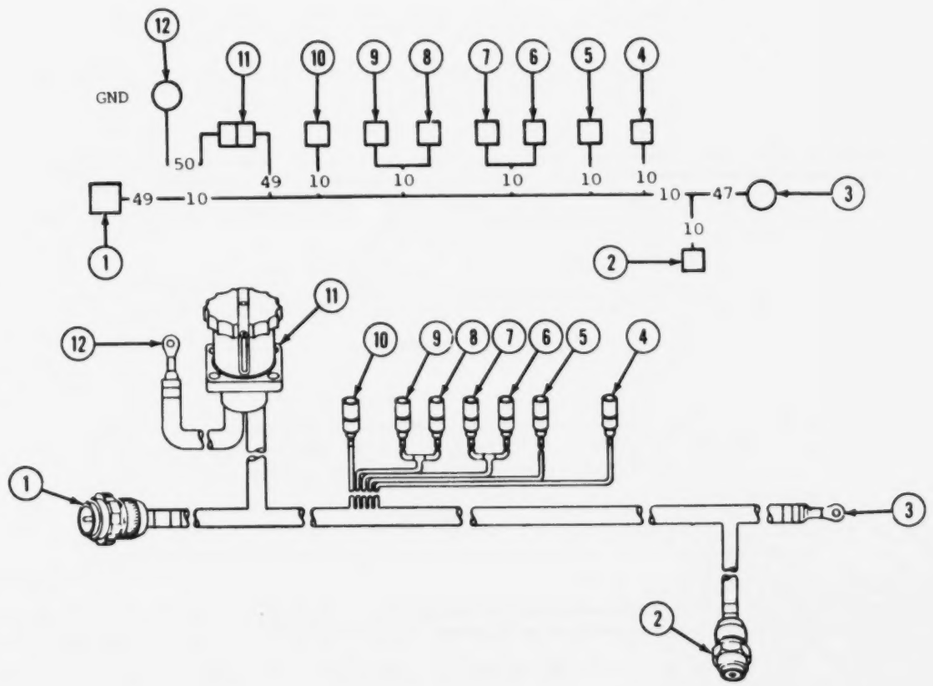
Applicable Configuration
M109A2 only

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Connector bulkhead (to slave receptacle)	49
2.	Connector accessory control box	10
3.	Connector slip ring segment board	47
4.	Connector hull lighting harness (interconnects with wire 15)	10
5.	Connector starter switch/flame heater switch circuit breaker (to wire 15)	10
6.	Connector fuel pump circuit breaker (to wire 76)	10
7.	Connector fuel prime pump switch circuit breaker (to wire 458)	10
8.	Connector master warning light/ engine instrumentation circuit breaker (to wire 27)	10
9.	Connector bilge pump switch circuit breaker (to wire 450)	10
10.	Connector auxiliary outlet/dome light circuit breaker (to wires 37-38)	10
11.	Connector slave receptacle	49
12.	Ground	50

NOTE

Harness P/N 11593784 is only used on M109A2/M109A3 vehicles.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TA472309

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-41. POWER LEAD WIRING HARNESS (11593784) - CONTINUED

a. Disassembly/Repair

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock or burns.

NOTE

Removal and installation of the power lead wiring harness is described in TM 9-2350-311-34-1.

Disassemble the harness in accordance with Chapter 2 (ref. p. 2-23).

b. Assembly

Assemble harness in reverse order of disassembly (ref. p. 2-23).

8-42. POWER LEAD (12260266) AND NATO SLAVE RECEPTACLE (11674728)

This task covers:

a. Disassembly/Repair b. Assembly

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

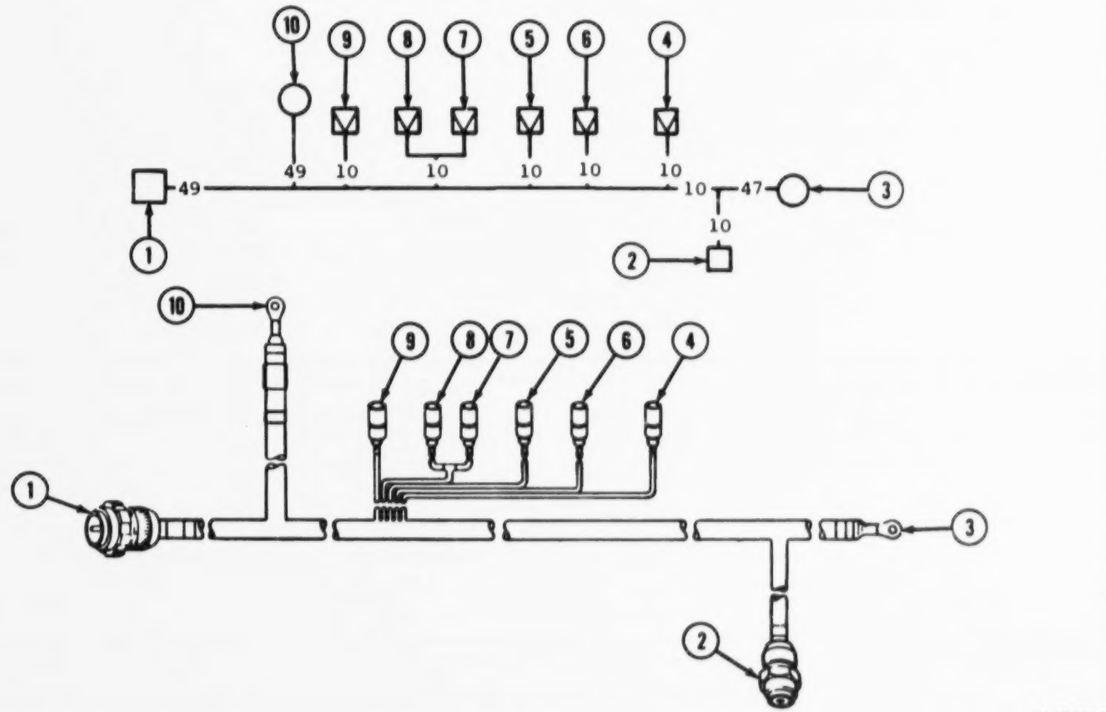
Connector Number	Electrical Lead To	Wire No.
1.	Connector bulkhead (to NATO slave receptacle)	49
2.	Connector accessory control box	10
3.	Connector slip ring segment board	47
4.	Connector hull lighting harness (interconnects with wire 15)	10
5.	Connector starter switch/flame heater switch circuit breaker (to wire 10)	10
6.	Connector fuel prime pump switch circuit breaker (to wire 458)	10
7.	Connector master warning light/ engine instrumentation circuit breaker (to wire 27)	10
8.	Connector bilge pump switch circuit breaker (to wire 450)	10
9.	Connector auxiliary outlet/dome light circuit breaker (to wires 37-38)	10
10.	Connector NATO slave receptacle	49

NOTE

Harness P/N 12260266 with NATO slave receptacle is only used on M109A2/M109A3 vehicles.
Refer to p. 8-68 for removal and installation of NATO slave receptacle.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-42. POWER LEAD (12260266) AND NATO SLAVE RECEPTACLE (11674728) - CONTINUED



WARNING

Be certain MASTER switch is off when working on hull electrical systems to avoid electrical shock and burns.

a. Disassembly/Repair

Disassemble harness leads in accordance with Chapter 2 (ref. p. 2-23).

b. Assembly

Assemble harness leads in reverse order of disassembly (ref. p. 2-23).

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-42.1. POWER LEAD (12268304) - M109A4

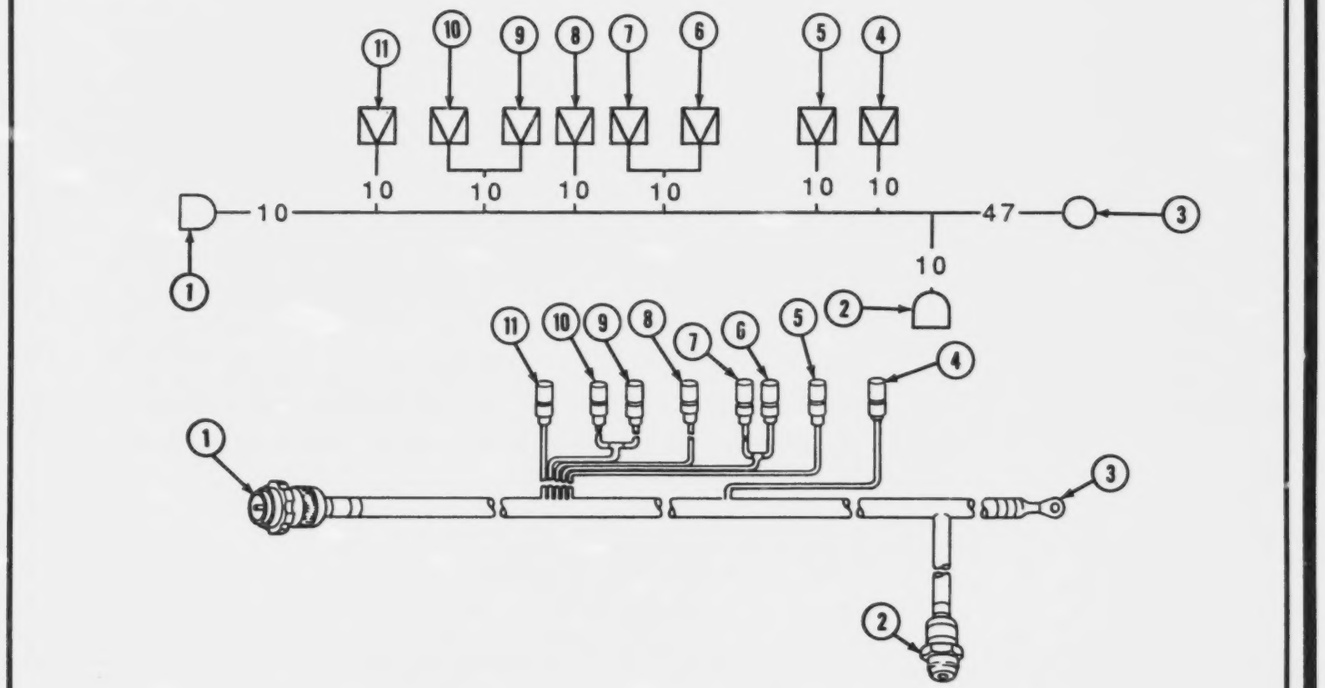
This task covers:

a. Disassembly/Repair b. Assembly

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To:	Wire No.
1.	Connector bulkhead	10
2.	Connector accessory control box	10
3.	Connector slip ring segment board	47
4.	Connector hull lighting harness (interconnects with wire 15)	10
5.	Connector NBC circuit breaker (to wire 438)	10
6.	Connector fuel prime pump switch circuit breaker (to wire 458)	10
7.	"Y" Connector in-tank fuel pump system relay (to wire 10)	10
8.	Connector starter switch/flame heater switch circuit breaker (to wire 10)	10
9.	Connector master warning light/ engine instrumentation circuit breaker (to wire 27)	10
10.	Connector bilge pump switch circuit breaker (to wire 450)	10
11.	Connector auxiliary outlet/dome light circuit breaker (to wires 37-38)	10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ELECTRICAL SYSTEM - SECTION III. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-42.1. POWER LEAD (12268304) - M109A4 - CONTINUED

WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock and burns.

a. Disassembly/Repair

Disassemble harness leads in accordance with Chapter 2 (ref. p. 2-23).

b. Assembly

Assemble harness leads in reverse order of disassembly (ref. p. 2-23).

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-43. PORTABLE INSTRUMENT PANEL WIRING HARNESS (12260298)

This task covers:

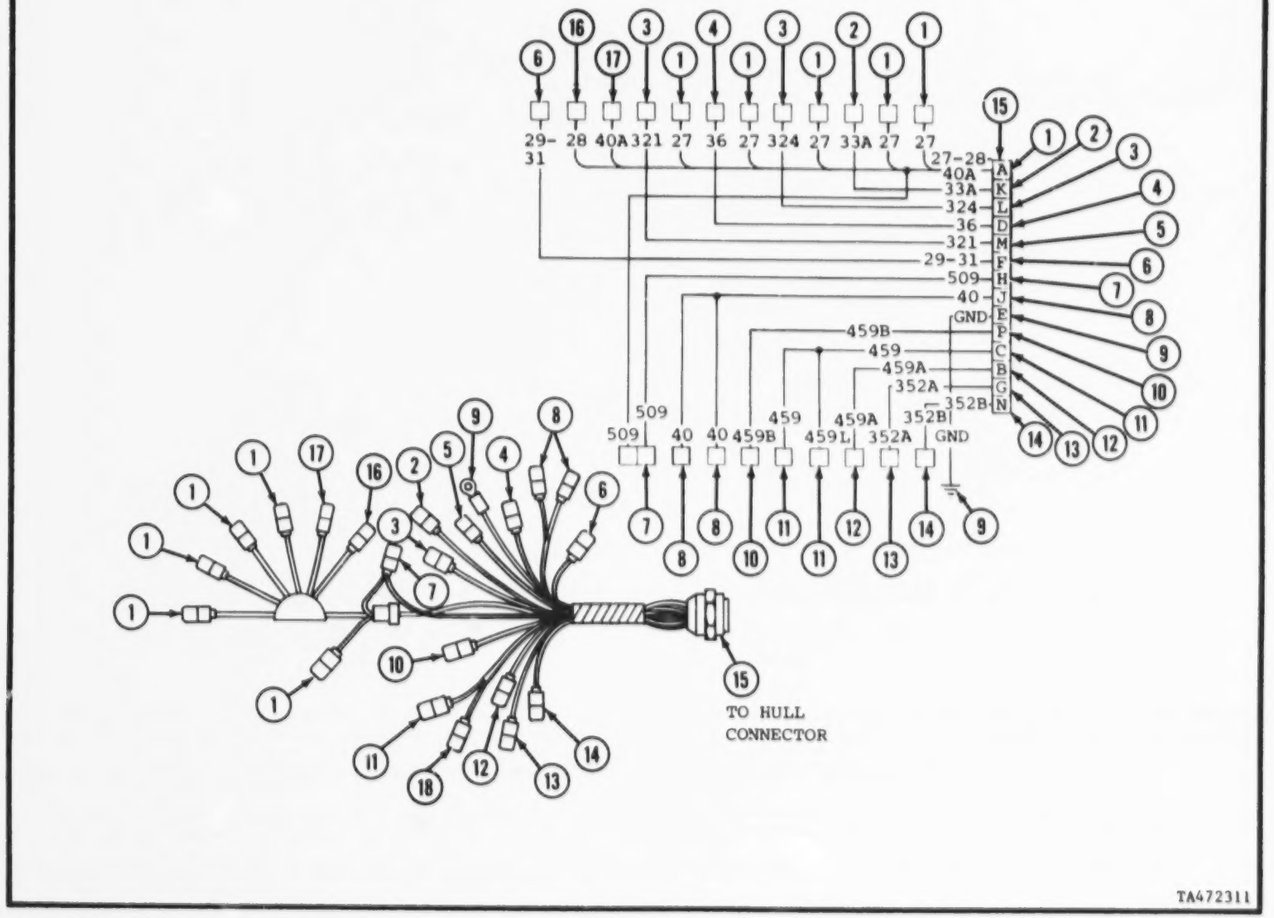
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector number	Electrical Lead To	Wire No.
1.	Power lead: engine instrumentation	27
2.	Engine water temperature lead	33A
3.	Transmission oil temperature lead	324
4.	Engine oil pressure lead	36
5.	Transmission oil pressure lead	321
6.	Fuel gage lead	29-31
7.	Warning lamp lead	509
8.	Panel lights	40
9.	Ground	GND

Connector Number	Electrical Lead To	Wire No.
10.	Master switch output lead	459B
11.	Master switch input	459
12.	Master switch auxiliary outlet (M109A2/A3 only)	459A
13.	Coolant indicator	352A
14.	Coolant indicator	352B
15.	Connector harness 12260258	
16.	Battery indicator	28
17.	Fuel gage	40A
18.	Master Switch Warning Light	459L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459B
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459L
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352B
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TO HULL
CONNECTOR
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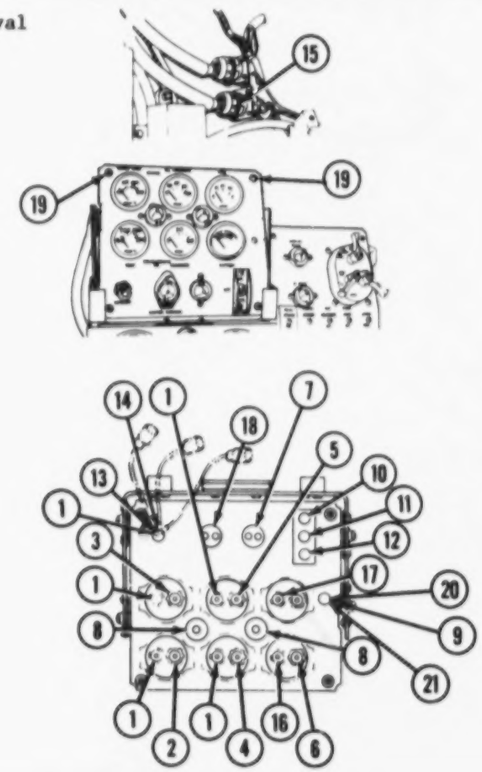
ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-43. PORTABLE INSTRUMENT PANEL WIRING HARNESS (12260298) - CONTINUED

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect harness connector (15) at hull bulkhead - driver's compartment.

4 Loosen four studs (19) at portable instrument panel. Pull cover outward to expose electrical leads to instruments.

5 Remove nut (20) and washer (21). Release ground lead (9) and replace screw and washer.

6 Disconnect 21 electrical connectors (1 through 8, 10 through 14 and 16 through 18) at instrument panel. Connector (12) is plugged on M109A4 vehicles.

7 Remove wiring harness 12260298 and grommet from panel assembly.

TA472312

b. Disassembly/Repair

Disassemble wiring harness (ref. p. 2-24).

c. Assembly

Assemble wiring harness in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-44. INTERCOM/TELEPHONE WIRING HARNESS (10942317) AND SLIP RING TELEPHONE FEED WIRING HARNESS (10897989)

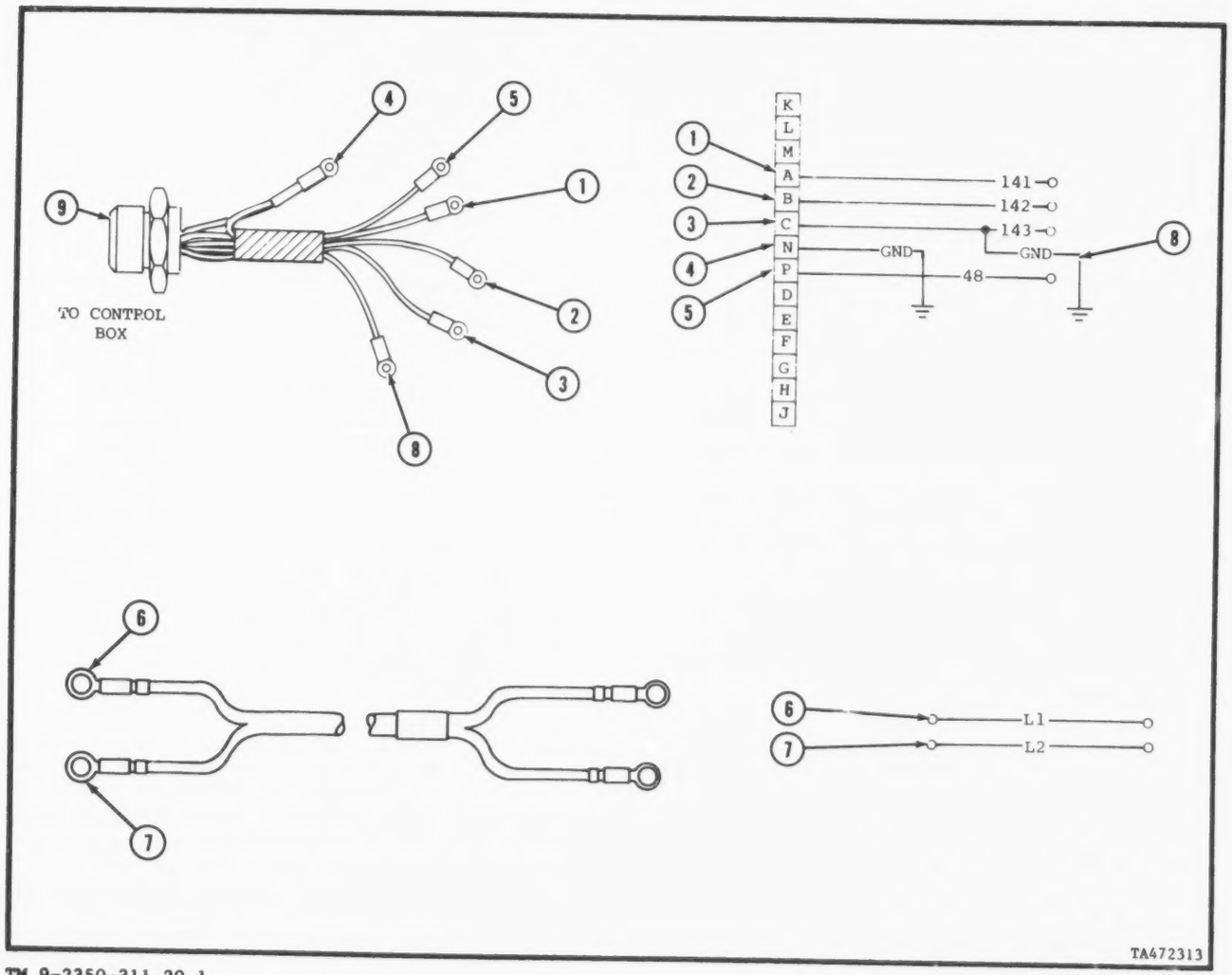
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.	Connector Number	Electrical Lead To	Wire No.
1.	No. 1 circuit intercom	141	6.	Telephone lead	L1
2.	No. 2 circuit intercom	142	7.	Telephone lead	L2
3.	No. 3 circuit intercom	143	8.	Ground	GND
4.	Ground	GND	9.	Connector	
5.	Power lead	48			


TO CONTROL BOX
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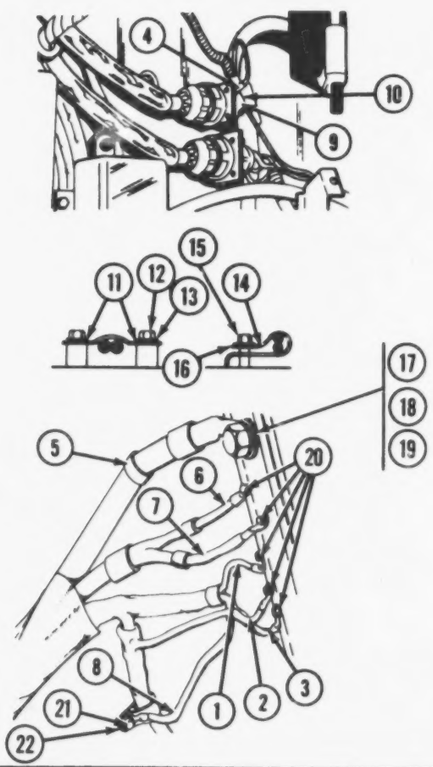
L2
TA472313

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-44. INTERCOM/TELEPHONE WIRING HARNESS (10942317) AND SLIP RING TELEPHONE FEED WIRING HARNESS (10897989) - CONTINUED

a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to aviod electrical shock and burns.

1 Disconnect connector (9) and ground lead (4) at driver's compartment. Remove ground screw (10).

2 Remove two plastic attaching straps (11), four screws (12) and four washers (13) located over air cleaner blower.

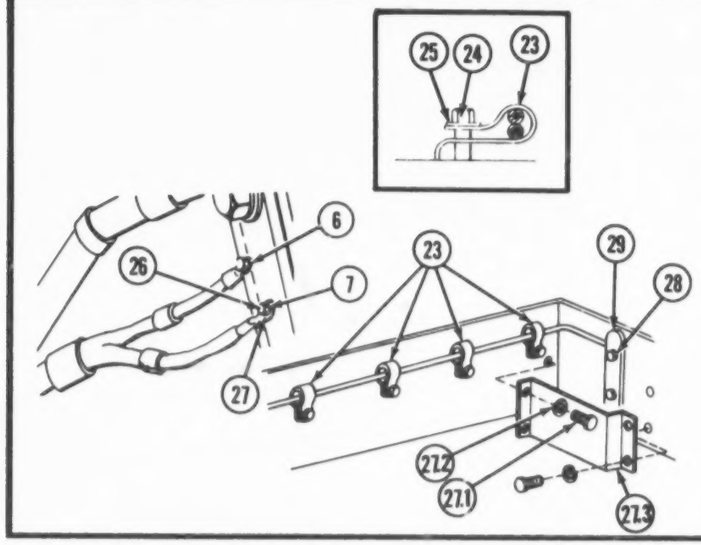
3 Remove nine plastic attaching straps (14), nine screws (15), and nine washers (16) located between driver's instrument panel and segment board.

4 Remove screw (17), nut (18) and washer (19), at segment board. Release wire 48 (5) and re-install screw, nut and washer.

5 Remove five screws (20) at segment board. Release wire 41, 42, 43, L1, and L2 (1, 2, 3, 6 and 7).

6 Remove screw (21) and washer (22) to release ground (8).

TA472314



NOTE

Harness 10897989 contains telephone lead L1 and L2 from segment board to hull terminals.

7 Remove seven plastic attaching straps (23), seven screws (24) and seven washers (25).

8 Remove two nuts (26) and two washers (27) and release wires L1 and L2 (6 and 7).

8.1 On M109A4 vehicles, remove four screws (27.1), four lockwashers (27.2) and guard (27.3).

9 Remove two plate screws (28).

10 Remove wires L1 (6) and L2 (7) from hull. Pull wire ends through hull at plate (29).

b. Installation

Install in reverse order of removal.

TA472315

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-45. RECTIFIER TO VOLTAGE REGULATOR (11593806)

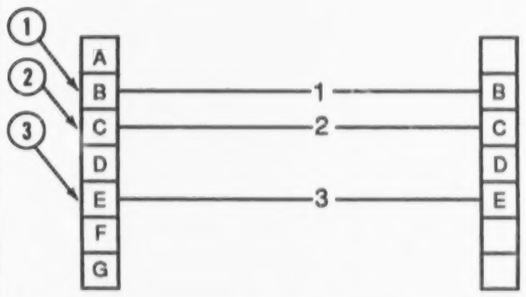
This task covers:

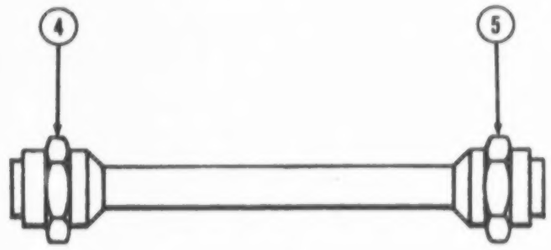
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Radio noise filter circuit	1
2.	Positive feed	2
3.	Ground circuit	3



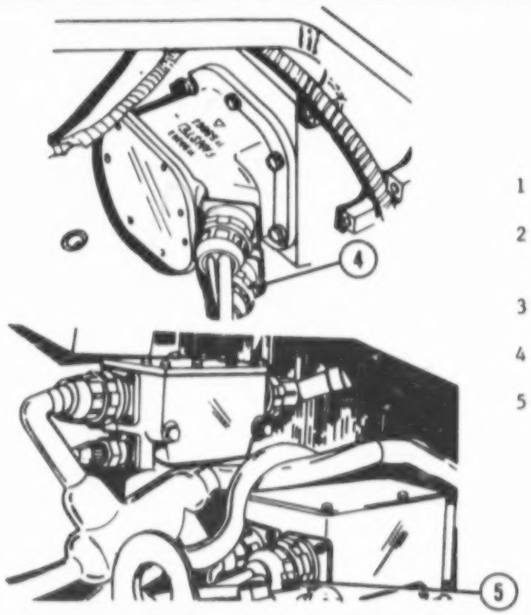


NOTE

Harness P/N 11593806 is used only on M109A2/M109A3 vehicles.

TA472316

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Open transmission access doors (ref. p. 4-10).

3 Remove connector (4) at rectifier.

4 Remove connector (5) at voltage regulator.

5 Remove harness (11593806).

b. Disassembly/Repair

Disassemble wiring harness (ref. p. 2-23).

c. Assembly

Assemble wiring harness (ref. p. 2-23).

d. Installation

Install wiring harness in reverse order of removal.

TA472317

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-45.1. RECTIFIER TO VOLTAGE REGULATOR (12268303) - M109A4

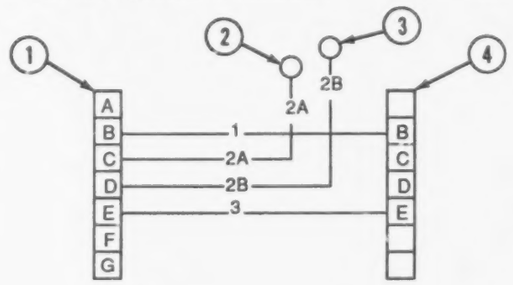
This task covers:

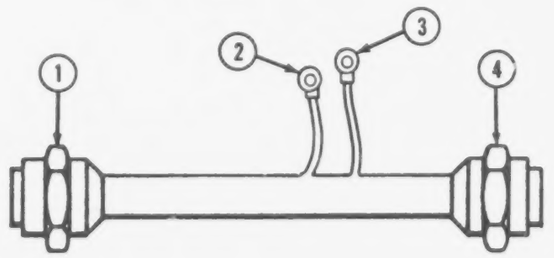
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

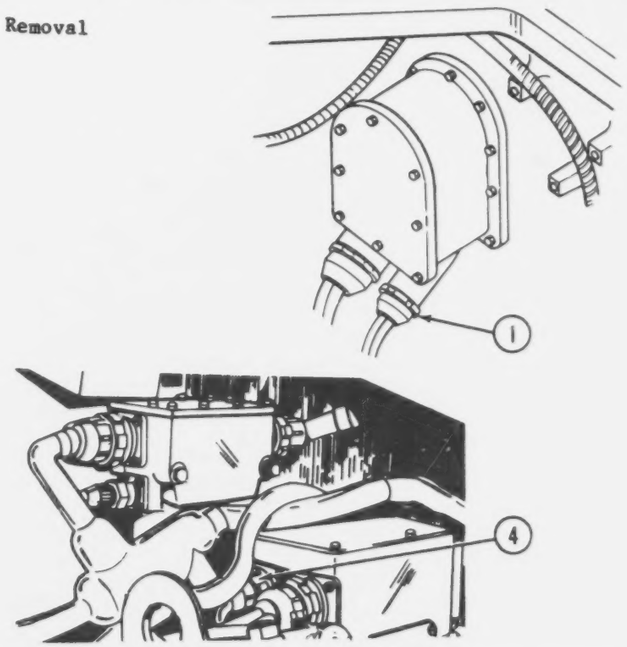
Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Rectifier	
2.	Battery positive terminal	2A
3.	Battery positive terminal	2B
4.	Regulator	





a. Removal



1 Disconnect batteries (ref. p. 8-56).

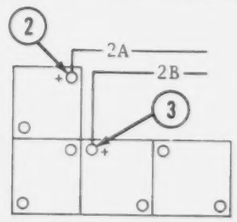
2 Open transmission access doors (ref. p. 4-10).

3 Remove connector (1) at rectifier.

4 Remove connector (4) at voltage regulator.

5 Remove two leads (2) and (3) at battery terminals.

6 Remove harness (11593806).



b. Disassembly/Repair

Disassemble wiring harness (ref. p. 2-23).

c. Assembly

Assemble wiring harness (ref. p. 2-23).

d. Installation

Install wiring harness in reverse order of removal.

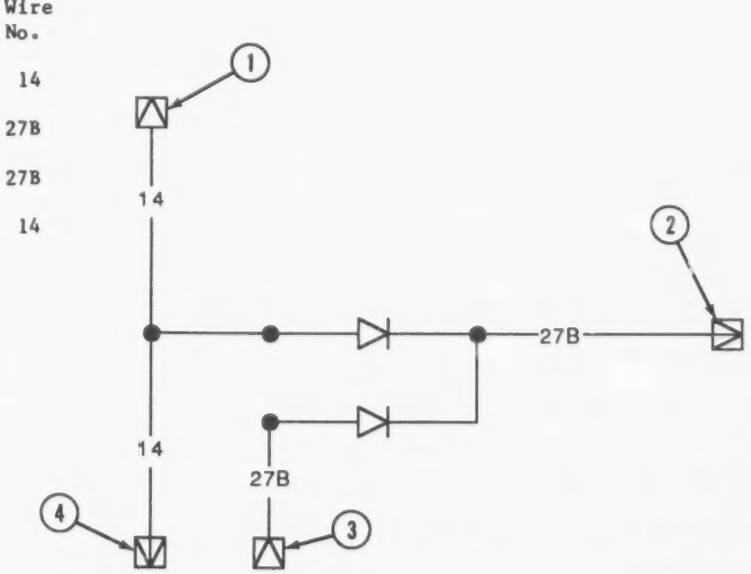
ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

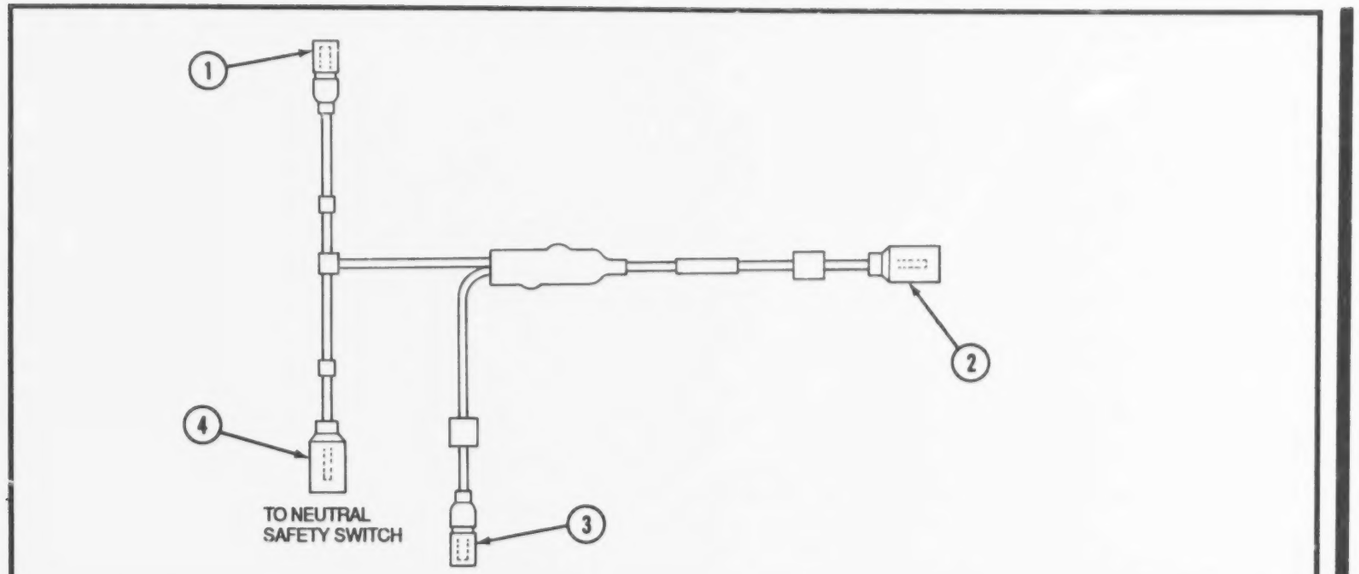
8-45.2. DIODE HARNESS ASSEMBLY (12268417) - M109A4

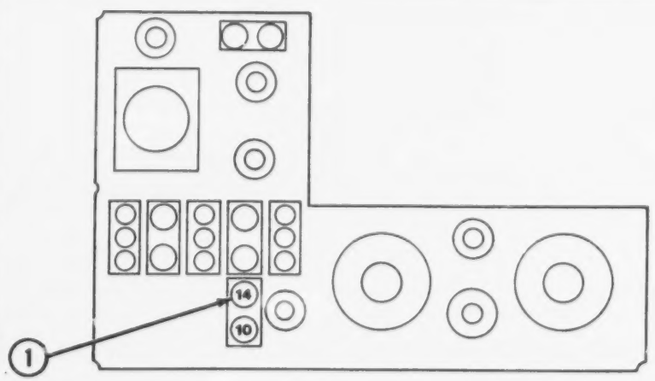
This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1	Starter	14
2	Bulkhead to portable instrument panel wiring harness	27B
3	Intank fuel pump system lead assembly	27B
4	Bulkhead to portable instrument panel wiring harness	14







1 Disconnect batteries (ref. p. 8-56).

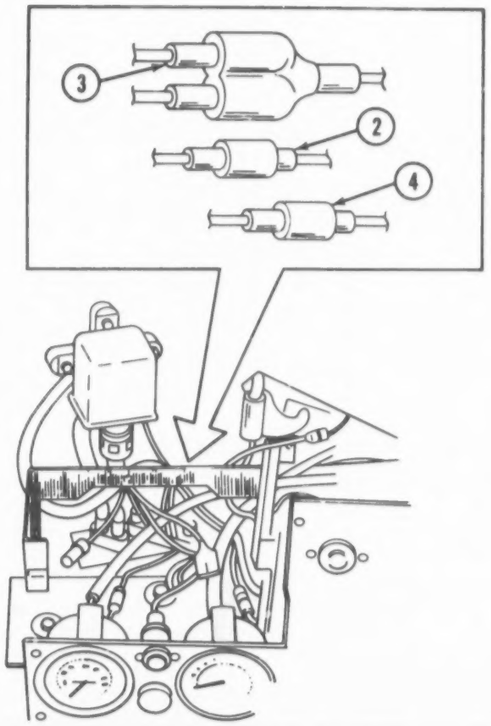
2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connector (1) at starter switch.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-45.2. DIODE HARNESS ASSEMBLY (12268417) - M109A4 - CONTINUED

a. Removal - Continued



4 Disconnect connector (2) at wire 27B.

5 Disconnect electrical connector (3) at "Y" connector.

6 Disconnect electrical connector (4) at wire 14.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly (ref. p. 2-23).

d. Installation

Install in reverse order of removal.

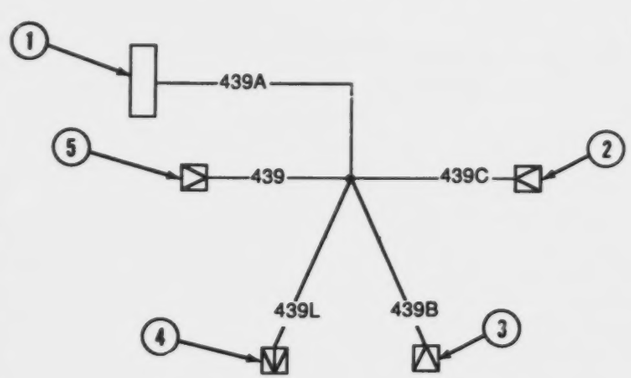
ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

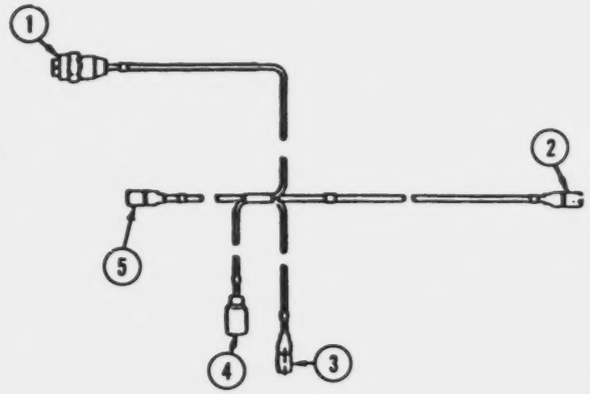
8-45.3. VENTILATED FACE PIECE SYSTEM POWER HARNESS (12352794) - M109A4

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.	Connector Number	Electrical Lead To	Wire No.
1.	NBC air purifier	439A	4.	NBC indicator light	439L
2.	Gunner's NBC heater	439C	5.	NBC power switch	439
3.	Driver's NBC heater	439B			





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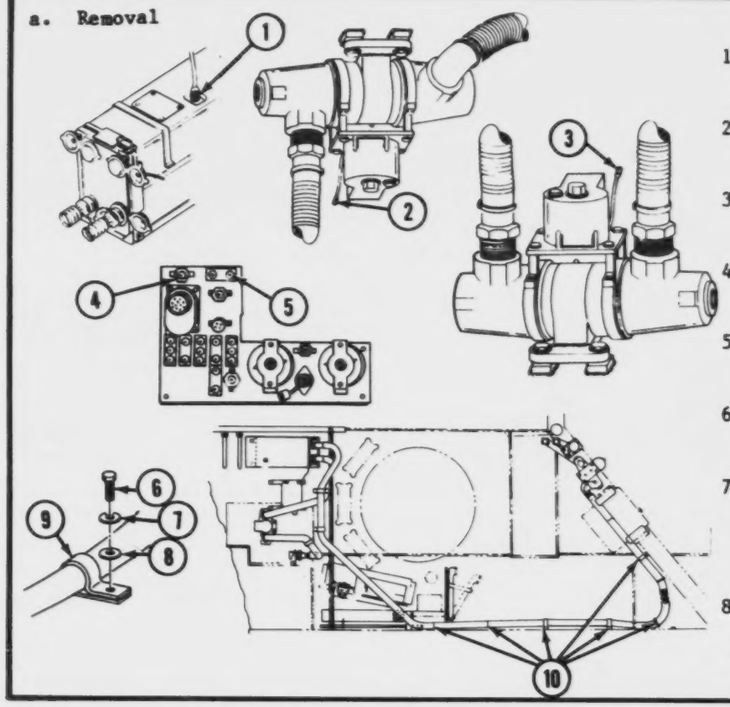
a. Removal



1 Disconnect connector (1) from NBC air purifier.

2 Disconnect connector (3) from driver's heater.

3 Remove portable instrument panel (ref. p. 8-22).

4 Disconnect connector (4) from NBC indicator light.

5 Disconnect connector (5) from NBC power switch.

6 Disconnect connector (2) from gunner's heater.

7 Remove seven screws (6), seven lockwashers (7), seven washers (8) and seven straps (9). Release harness 12352794 and reinstall straps.

8 Cut six straps (10) and remove harness.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-45.4. NATO SLAVE TO EXTERNAL POWER WIRING HARNESS (12353400) - M109A4

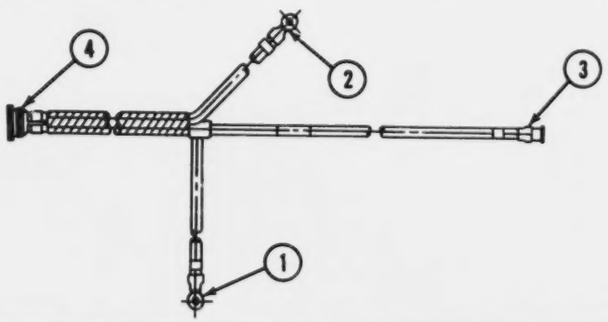
This task covers:

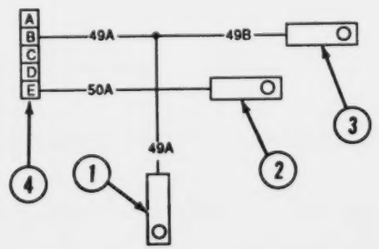
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

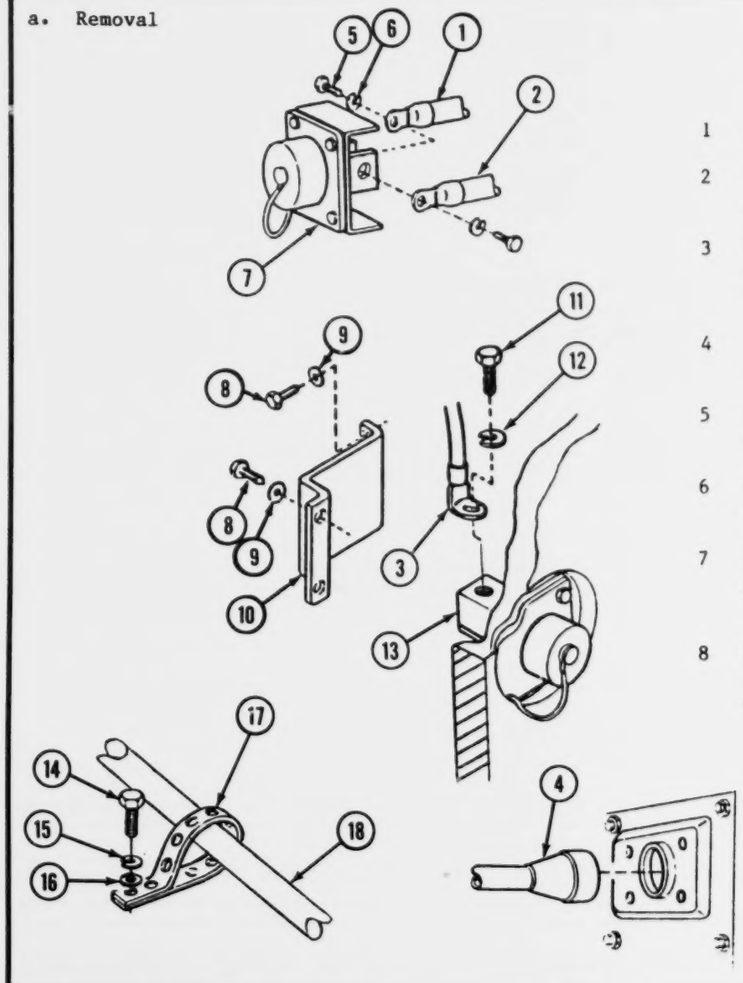
Materials/Parts
Tape, electrical (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Slave start receptacle	49B
2.	Slave start ground	50B
3.	External power receptacle connector	49B
4.	Driver's bulkhead	49A 50A





a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Cut electrical tape to expose slave start connections.

3 Remove two screws (5) and two lockwashers (6) to disconnect power (1) and ground lead (2) from slave receptacle (7),

4 Disconnect slave connector (4) at driver's bulkhead

5 Remove four screws (8), four lockwashers (9) and external power receptacle guard (10).

6 Cut electrical tape to expose external power receptacle connections.

7 Remove screw (11) and lockwasher (12) to disconnect cable (3) from external power receptacle (13).

8 Remove 14 screws (14), 14 lockwashers (15), 14 washers (16), 14 straps (17) and lift out wiring harness (18).

ELECTRICAL SYSTEMS - SECTION III. POWERPLANT AND HULL WIRING HARNESSES - CONTINUED

8-45.4. NATO SLAVE TO EXTERNAL POWER WIRING HARNESS (12353400) -M109A4 - CONTINUED

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.
Tape all exposed electrical connections (as required).

NOTE

Refer to p. 8-68 for removal and installation of NATO slave receptacle and p. 8-68.1 for removal and installation of external power receptacle.

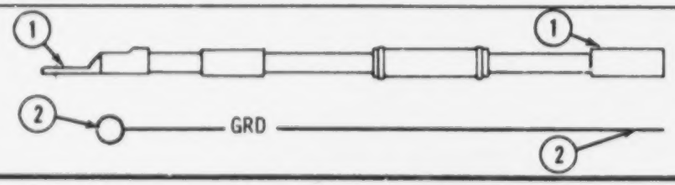
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS

8-46. ACCESSORY CONTROL BOX INDICATOR LIGHT GROUND LEAD (10925419)

This task covers:

a. Removal b. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Indicator light	GRD
2.	Ground	GRD



a. Removal

Remove indicator ground lead in accordance with the accessory control box disassembly instructions (ref. p. 8-32).

b. Installation

Install in reverse order of removal.

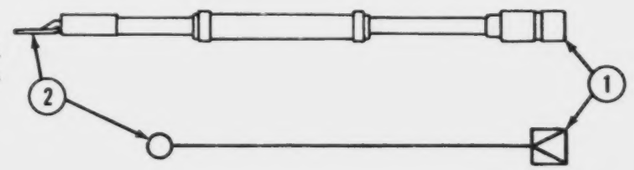
TA472318

8-47. ACCESSORY CONTROL BOX HEAT SELECTOR SWITCH TO CIRCUIT BREAKER LEAD (10930337-1)

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Circuit Breaker	400A
2.	Heat selector switch	400A



a. Removal

Remove heat selector switch to circuit breaker lead in accordance with the accessory control box disassembly instructions (ref. p. 8-32).

b. Disassembly

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472319

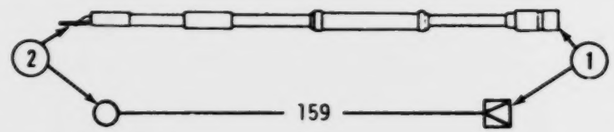
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-48. ACCESSORY CONTROL BOX VENTILATOR BLOWER SWITCH TO CIRCUIT BREAKER LEAD (10930337-2)

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Circuit breaker	159
2.	Ventilator blower switch	159



a. Removal

For removal of the ventilator blower switch to circuit breaker lead refer to the accessory control box disassembly instructions (ref. p. 8-32).

b. Disassembly

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

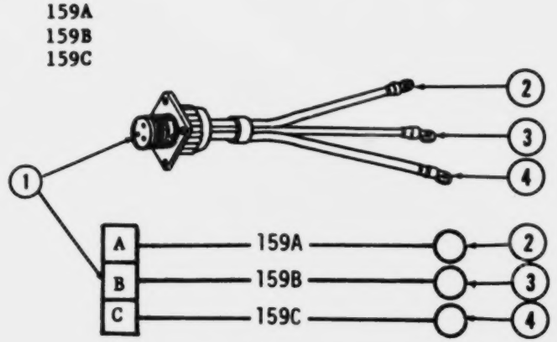
TA472320

8-49. ACCESSORY CONTROL BOX VENTILATOR BLOWER SWITCH LEAD (10925421)

This task covers:

a. Removal b. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Accesory control box to heater/ blower wiring harness (10925829)	
2.	Ventilator blower switch	159A
3.	Ventilator blower switch	159B
4.	Ventilator blower switch	159C



a. Removal

For removal refer to the accessory control box disassembly (ref. p. 8-32).

b. Installation

Install in reverse order of removal.

TA472321

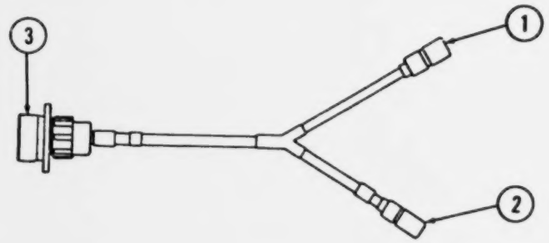
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

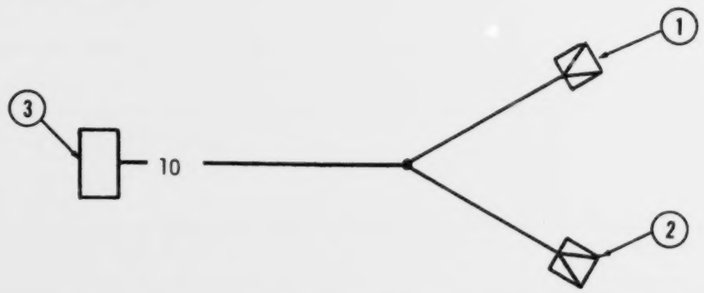
8-50. ACCESSORY CONTROL BOX POWER LEAD (10925418)

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Circuit breaker	10
2.	Circuit breaker	10
3.	Accessory control box body/ Electrical lead 12260266	10





TA472322

a. Removal

For removal of the accessory control box power lead see the accessory control box disassembly instructions (ref. p. 8-32).

b. Disassembly

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly (ref. p. 2-23).

d. Installation

Install in reverse order of removal.

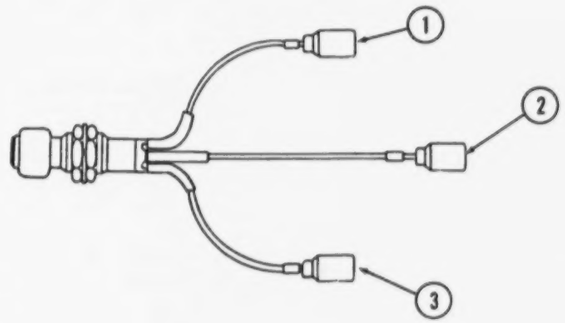
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

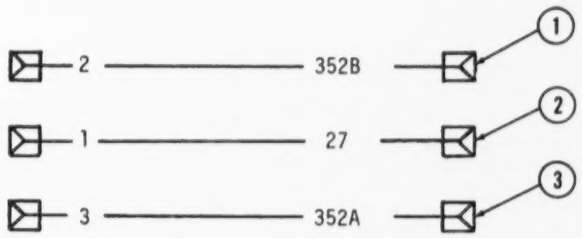
8-51. LOW COOLANT INDICATOR LIGHT ASSEMBLY (12260297)

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Low coolant indicator light assembly terminal 2	352B
2.	Low coolant indicator light assembly terminal 1	27
3.	Low coolant indicator light assembly terminal 3	352A



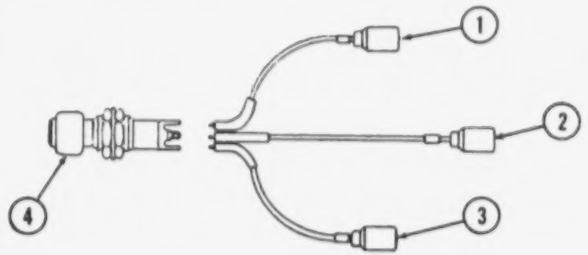


TA472323

a. Removal

For removal of the low coolant indicator light assembly see the driver's instrument panel disassembly instructions (ref. p. 8-22).

b. Disassembly



Disassemble the low coolant indicator light assembly by unsoldering leads (1, 2, and 3) from indicator light (4) in accordance with TB SIG 222.

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472324

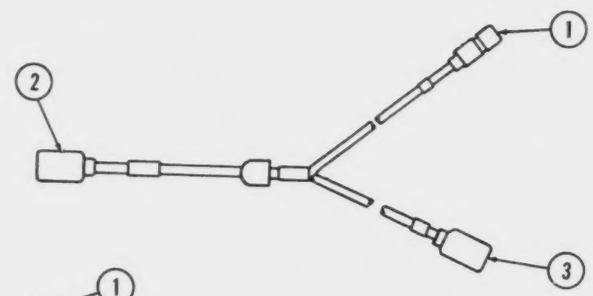
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

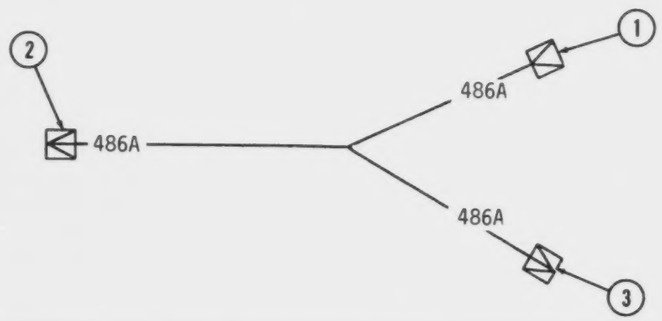
8-52. FLAME HEATER ELECTRICAL LEAD (10936488)

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

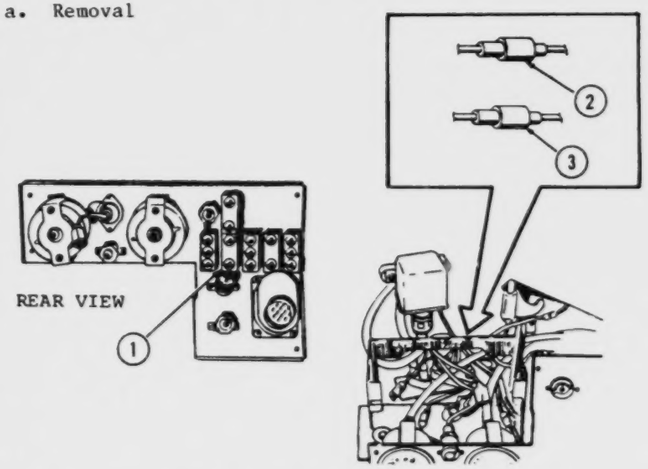
Connector Number	Electrical Lead To	Wire No.
1.	Flame heater switch	486A
2.	Bulkhead to portable instrument panel harness	486A
3.	Bulkhead to portable instrument panel harness	486A





TA472325

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connector (1) at flame heater switch.

4 Disconnect two connectors (2 and 3) at wires 486A and 486.

b. Disassembly

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472326

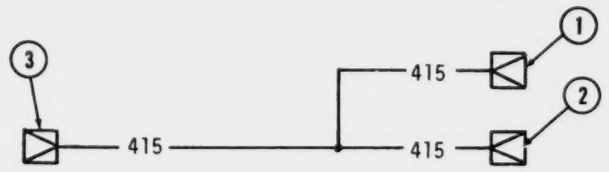
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-53. CIRCUIT BREAKER TO "Y" CONNECTOR LEAD (12268157)

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Circuit breaker	415
2.	Circuit breaker	415
3.	Air cleaner blower lead assembly	415

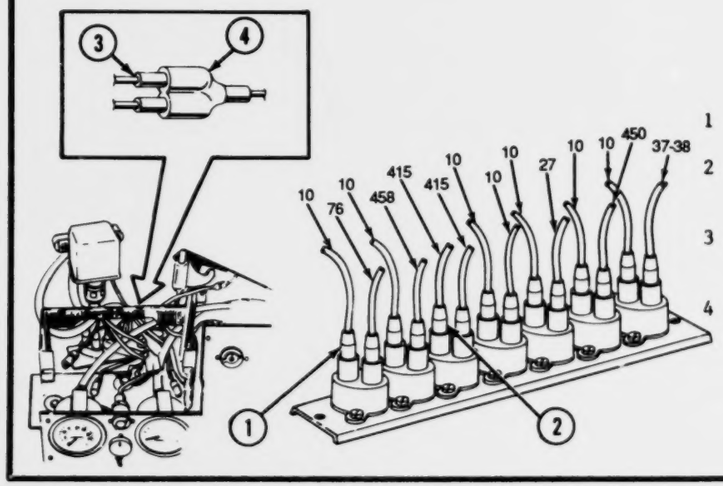


NOTE

Lead P/N 12268157 is only used on M109A2/A3 vehicles with POWER LEAD HARNESS P/N 12260266.

TA472327

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connectors (1 and 2) at circuit breakers.

4 Disconnect connector (3) at wire 415 connector (4).

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly (ref. p. 2-23).

d. Installation

Install in reverse order of removal.

TA472328

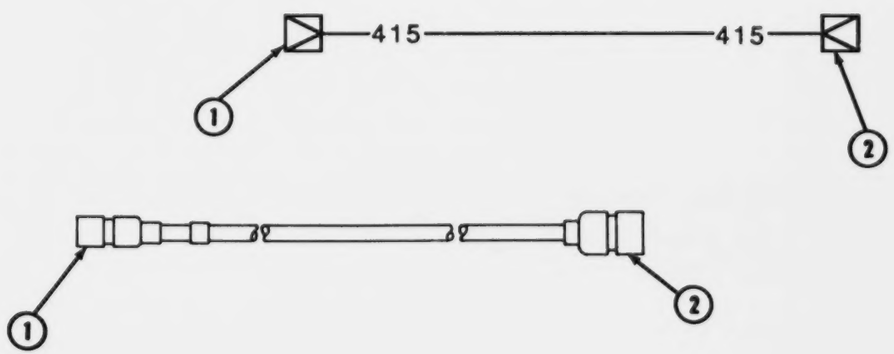
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-53.1. CIRCUIT BREAKER TO "Y" CONNECTOR LEAD (12353647) - M109A4

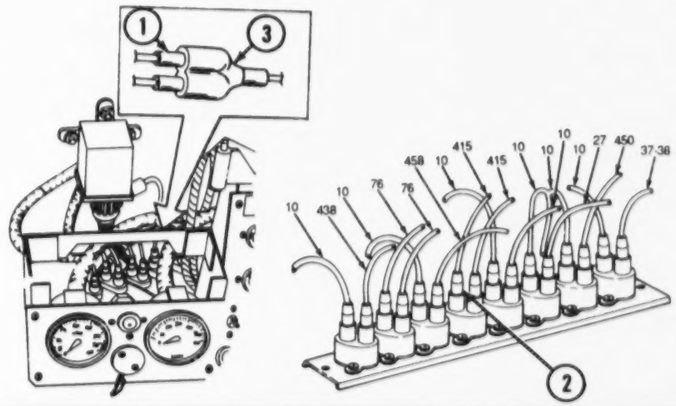
This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Power lead "Y" connector	415
2.	Circuit breaker	415



a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connector at circuit breaker.

4 Disconnect connector (1) at wire 415 connector (3).

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly (ref. p. 2-23).

d. Installation

Install in reverse order of removal.

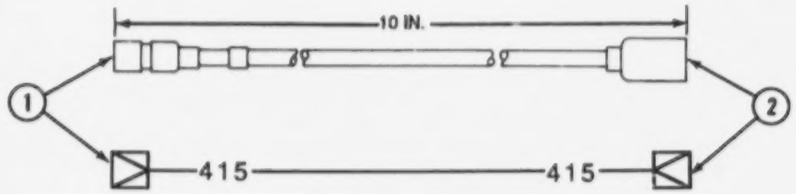
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-54. CIRCUIT BREAKER TO "Y" CONNECTOR LEAD (11682358)

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

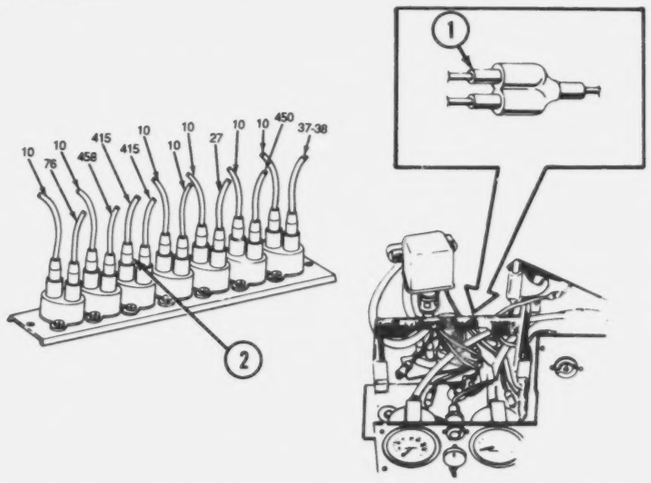
Connector Number	Electrical Lead To	Wire No.
1.	Air cleaner blower lead assembly	415
2.	Circuit breaker	415



NOTE

Lead P/N 11682358 is only used in vehicles with POWER LEAD HARNESS P/N 11593784.

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connector (1) behind driver's instrument panel.

4 Disconnect connector (2) at circuit breaker.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472330

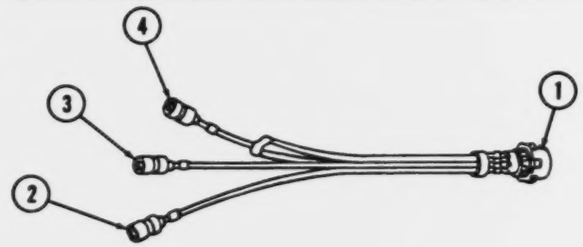
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

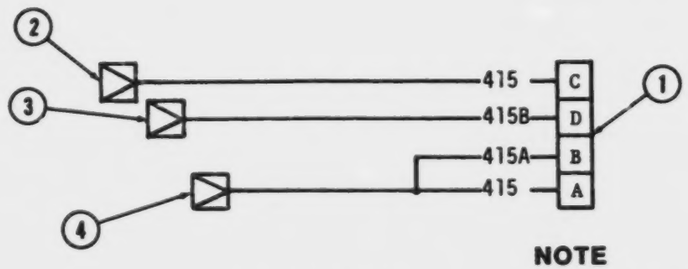
8-55. AIR CLEANER BLOWER LEAD ASSEMBLY (10897991)

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Air cleaner blower motor relay	
2.	Bulkhead to portable instrument panel wiring harness and circuit breaker to "Y" connector lead	415
3.	Bulkhead to portable instrument panel wiring harness	415A-415
4.	Bulkhead to portable instrument panel wiring harness	



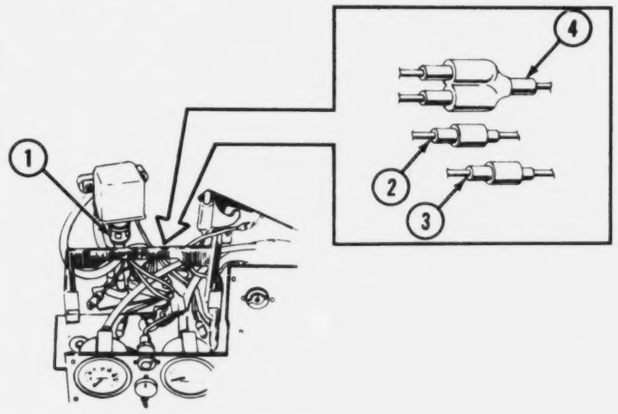


NOTE

Lead P/N 10897991 is used only on M109A2/M109A3 vehicles.

TA472331

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove Portable Instrument Panel (ref. p. 8-22).

3 Disconnect connector (1) at Air Cleaner Blower Motor Relay.

5 Disconnect connectors (2, 3 and 4).

b. Disassembly

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472332

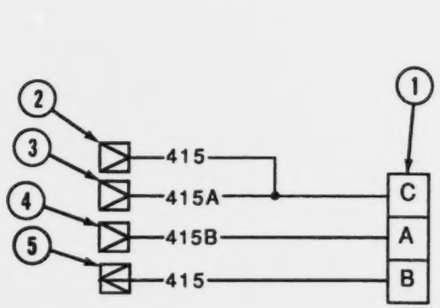
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

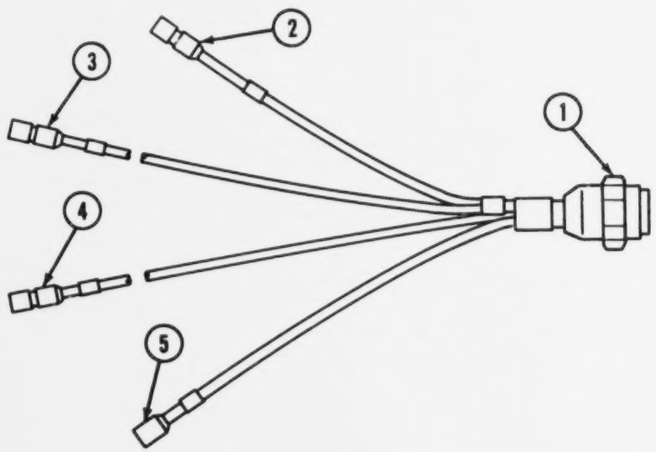
8-55.1. AIR CLEANER BLOWER LEAD ASSEMBLY (12353259) - M109A4

This task covers:

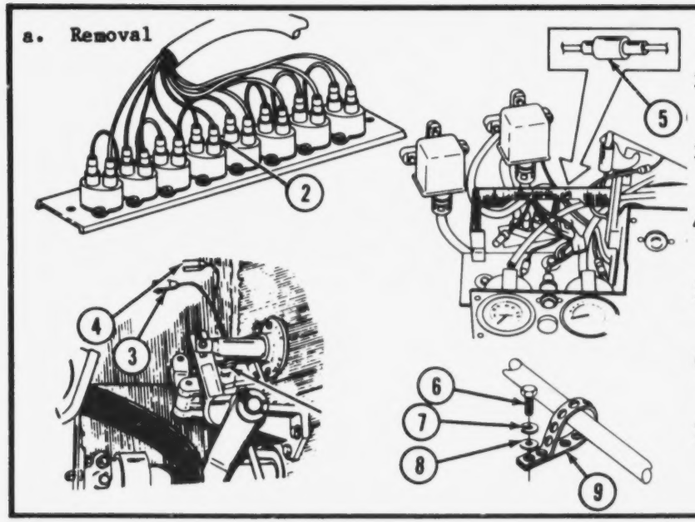
a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Air cleaner blower motor relay	
2.	Circuit breaker	415
3.	Neutral safety switch	415A
4.	Neutral safety switch	415B
5.	Air cleaner blower motors harness 10925829	415





a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connector (1) at air cleaner blower motor relay.

4 Disconnect connector (2) wire 415 at circuit breaker.

5 Disconnect connectors (3) and (4) at neutral safety switch.

6 Disconnect connector (5) at air cleaner blower motor lead wire 415.

7 Remove five screws (6), five lockwashers (7), five washers (8) and five straps (9). Remove harness.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

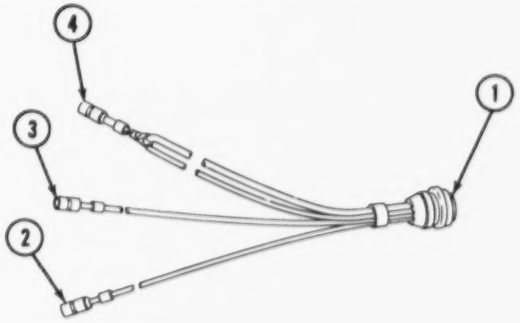
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

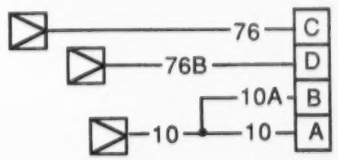
8-55.2. INTANK FUEL PUMP LEAD ASSEMBLY (12353646) - M109A4

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

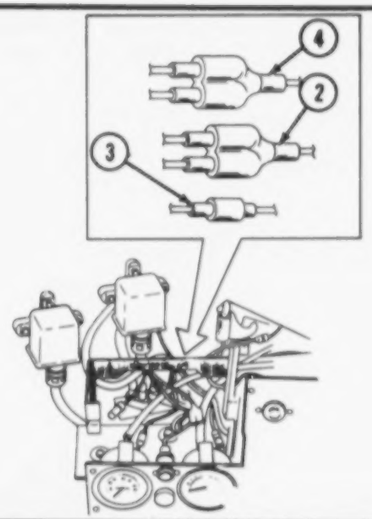
Connector Number	Electrical Lead To	Wire No.
1.	In-tank fuel pump relay	
2.	Diode harness assembly and circuit breaker to "Y" connector lead	76
3.	Bulkhead to portable instrument panel wiring harness	76B
4.	Power lead assembly and circuit breaker to "Y" connector lead.	10





TA472331

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove Portable Instrument Panel (ref. p. 8-22).

3 Disconnect connector (1) at fuel pump system relay.

4 Disconnect connector (2, 3 and 4).

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

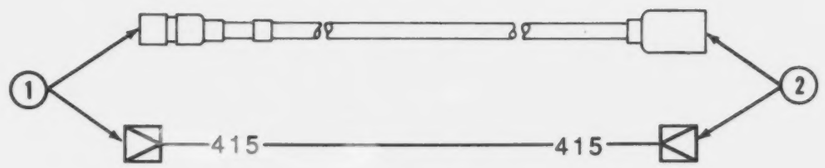
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-56. CIRCUIT BREAKER TO BLOWER MOTOR CIRCUIT LEAD ASSEMBLY (11682359)

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

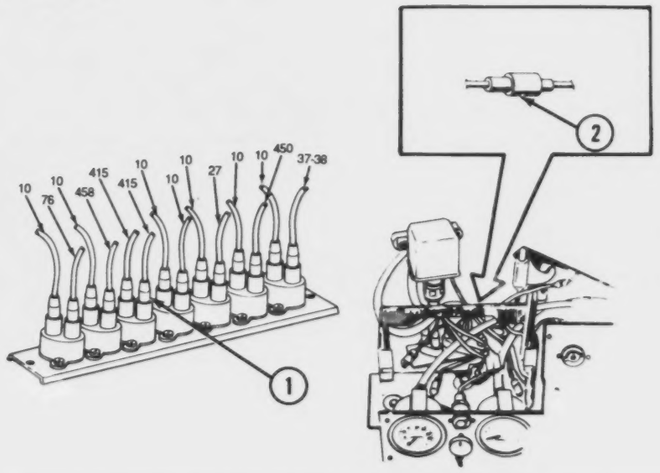
Connector Number	Electrical Lead To	Wire No.
1.	Circuit breaker	415
2.	Connector, harness 10925829	415



NOTE

Lead P/N 11682359 is used only on M109A2/A3 vehicles.

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove Portable Instrument Panel (ref. p. 8-22).

3 Disconnect connector (1) at circuit breaker.

4 Disconnect connector (2) at wire 415.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

TA472334

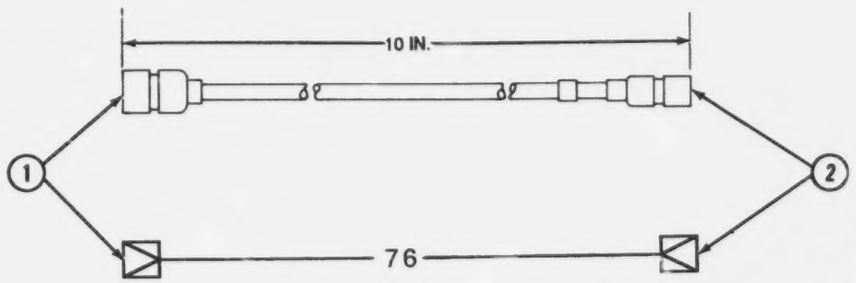
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-56.1. FUEL PUMP CIRCUIT BREAKER LEAD ASSEMBLY (11682358-1) - M109A4

This task covers:

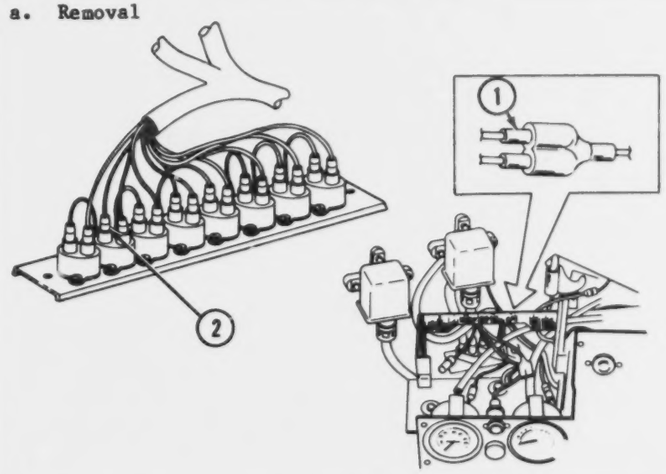
a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	In tank fuel pump lead assembly	76
2.	Circuit breaker	76



TA472335

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove portable instrument panel (ref. p. 8-22).

3 Disconnect connector (1) behind driver's instrument panel.

4 Disconnect connector (2) wire 76 at circuit breaker panel.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-57. MASTER WARNING LIGHT ASSEMBLY STEERING SHAFT (10922337)

This task covers:

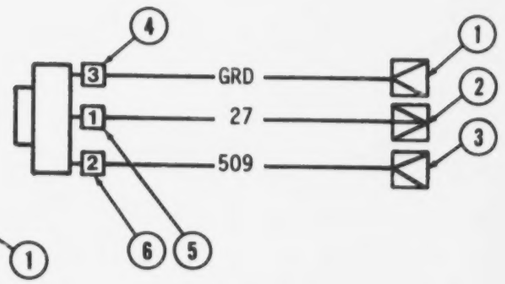
a. Removal b. Disassembly/Repair c. Assembly d. Installation

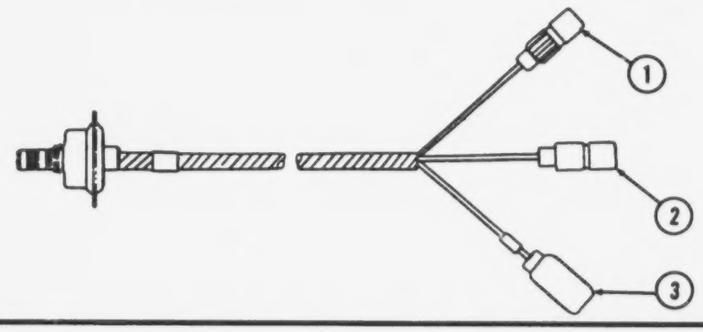
INITIAL SET-UP

Materials/Parts

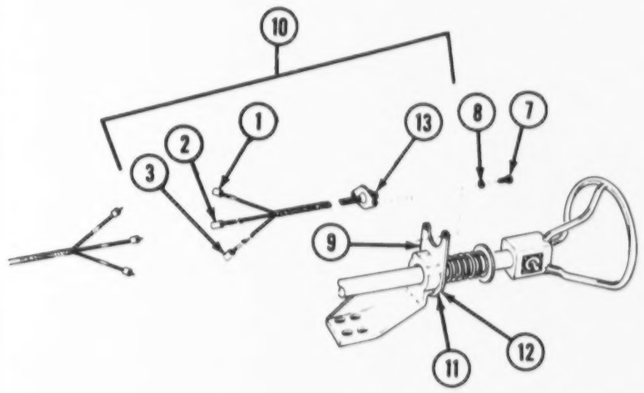
Electrical Coating Compound (Item 62, App. C)
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Wire GRD/Harness P/N 12260287	GRD
2.	Wire 27/Harness P/N 12260187	27
3.	Wire 509/Harness P/N 12260287	509
4.	Terminal 3/master warning light	GRD
5.	Terminal 1/master warning light	27
6.	Terminal 2/master warning light	509





a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock or burns.

1 To remove the master warning light, disconnect the three electrical connectors (1, 2, and 3) and remove two screws (7) and two lockwashers (8) located on top portion of the mounting bracket (9).

2 Remove master warning lights (10).

NOTE

To remove mounting bracket, remove steering wheel (ref. p. 9-12).

3 Remove three screws (11), three lockwashers (12) and three mounting brackets (9).

b. Disassembly/Repair

1 If required, unscrew cap (13), push in on LED and turn counterclockwise to remove.

2 Remove electrical tape for only the sections to be disassembled. Disassemble connectors in accordance with Chapter 2 (ref. p. 2-23).

3 Unsolder leads (1, 2 and 3) from Master warning light in accordance with TB SIG 222.

c. Assembly

1 Coat lamp socket with electrical coating compound (Item 62, App. C).

2 Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

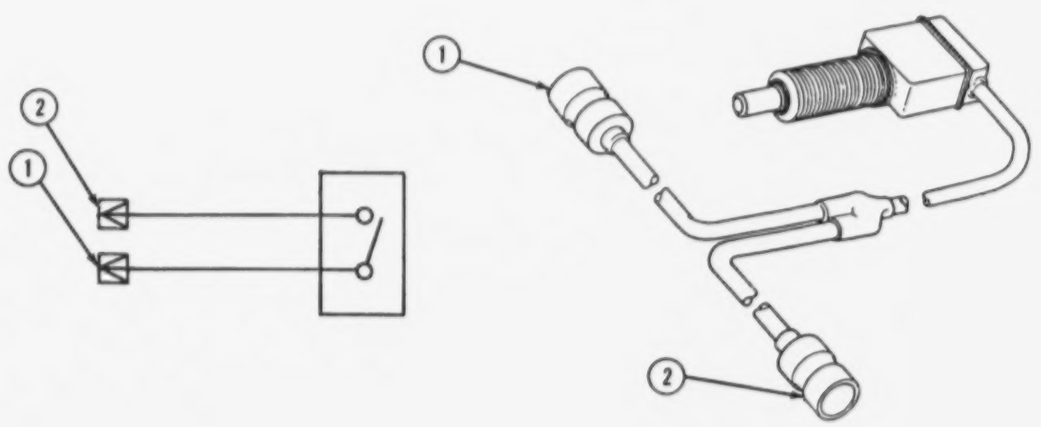
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-58. PARKING BRAKE LIGHT SWITCH ASSEMBLY (10930467)

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Wire 509E/Harness P/N 12260287	509E
2.	Wire 509E/Harness P/N 12260287	509E



TA472337

a. Removal

For removal of the parking light switch assembly see the service and parking brake linkage instructions (ref. p. 9-25).

b. Disassembly

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

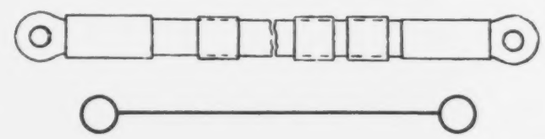
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-59. BATTERY TERMINAL CONNECTOR (10897992) AND GROUND CABLES (10897993)

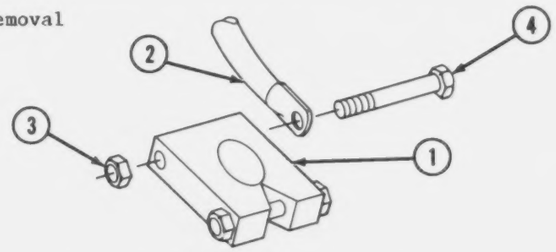
This task covers:

a. Removal b. Installation

Circuit Number	Cable Function
7.	Battery terminal connector
68.	Ground cable



a. Removal



1 Remove two battery ground cables and two battery cables with lugs (ref. p. 8-56).

2 Remove lugs (1) from cables (2) by removing nut (3) and bolt (4).

b. Installation

Install in reverse order of removal.

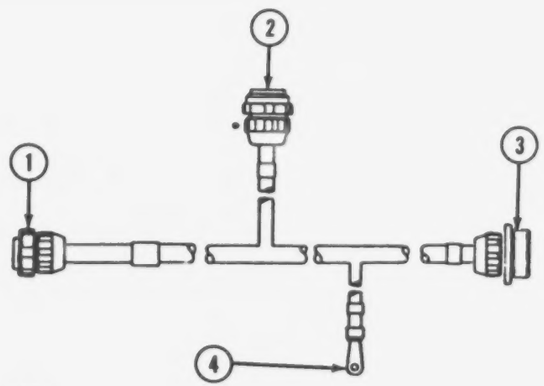
TA472338

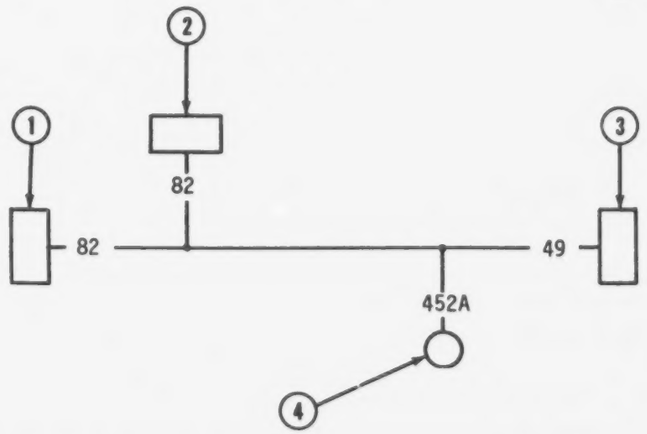
8-60. ENGINE BRACKET TO DRIVER'S BULKHEAD LEAD ASSEMBLY (11593782)

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Engine disconnect bracket	82
2.	Master relay	82
3.	Driver's bulkhead	49
4.	Bilge pump circuit breaker	452A





NOTE

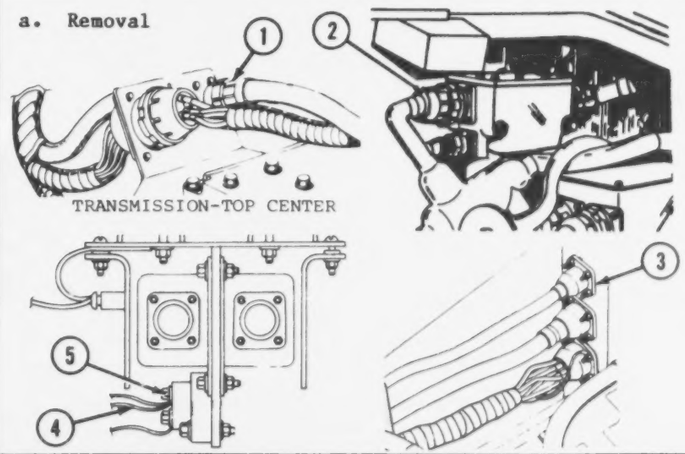
Harness P/N 11593782 is used only on M109A2/A3 vehicles.

TA472339

ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-60. ENGINE BRACKET TO DRIVER'S BULKHEAD LEAD ASSEMBLY (11593782) - CONTINUED

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Disconnect connector (1) at engine disconnect bracket.

3 Disconnect connector (2) at Master relay.

4 Disconnect connector (3) at driver's bulkhead.

5 Disconnect terminal (4) at bilge pump circuit breaker by removing nut (5).

b. Disassembly/Repair

Disassemble lead assembly in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

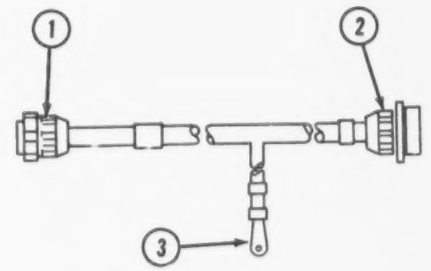
TA472340

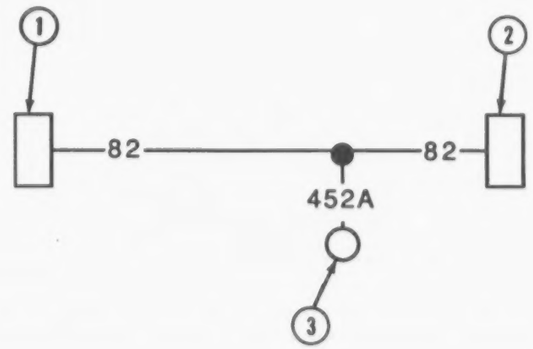
8-60.1. MASTER RELAY TO DRIVER'S BULKHEAD LEAD ASSEMBLY (12353403) - M109A4

This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Master relay	82
2.	Driver's bulkhead	82
3.	Bilge pump circuit breaker	452A

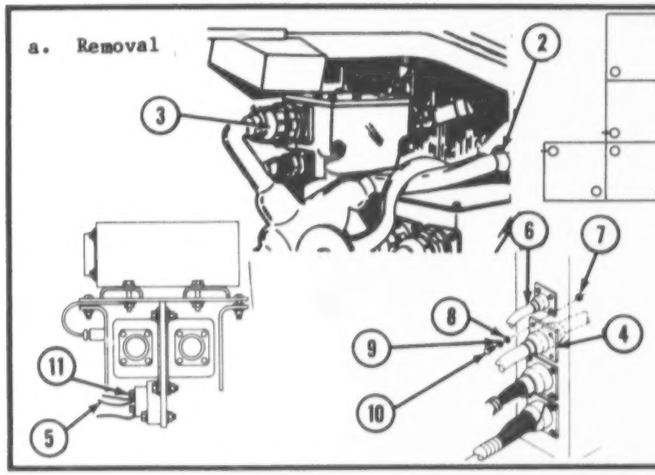




ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-60.1. MASTER RELAY TO DRIVER'S BULKHEAD LEAD ASSEMBLY (12353403) -M109A4 - CONTINUED

a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove two batteries (1) and clamp (2).

3 Disconnect connector (3) at Master relay.

4 Disconnect power lead wiring harness (6) from driver's bulkhead.

5 Remove four nuts (7), four lockwashers (8), four washers (9), four screws (10) and remove connector (4) from bulkhead.

6 Disconnect terminal (5) at bilge pump circuit breaker by removing nut (11).

b. Disassembly/Repair

Disassemble lead assembly in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

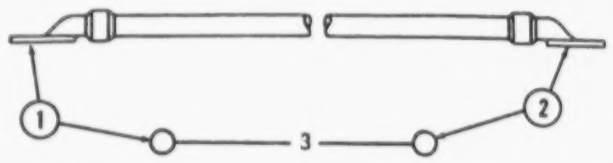
Install in reverse order of removal.

8-61. ENGINE ELECTRICAL GROUND LEAD (MS35915-10)

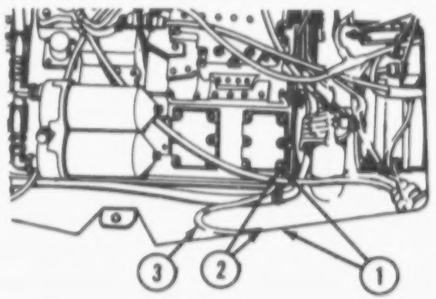
This task covers:

a. Removal b. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Transmission front	3
2.	Vehicle hull	3



a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical systems to avoid electrical shock and burns.

1 Open transmission access doors (ref. p. 4-10).

2 Remove two bolts (1), four lockwashers (2) and engine electrical ground lead (3).

b. Installation

Install in reverse order of removal.

TA472341

ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-62. STARTER TO ENGINE ELECTRICAL DISCONNECT (12353072) - M109A4

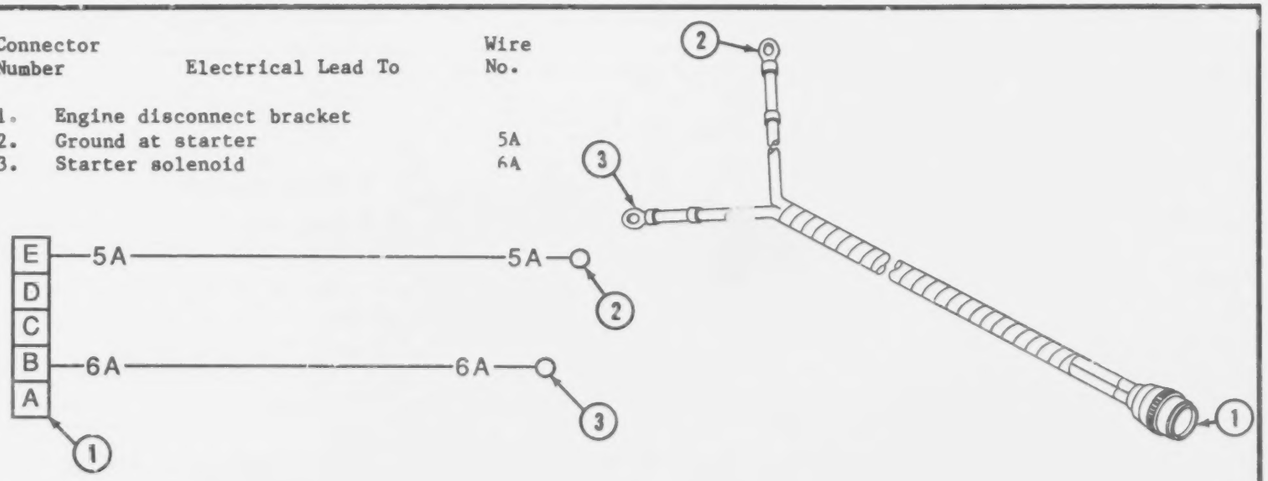
This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

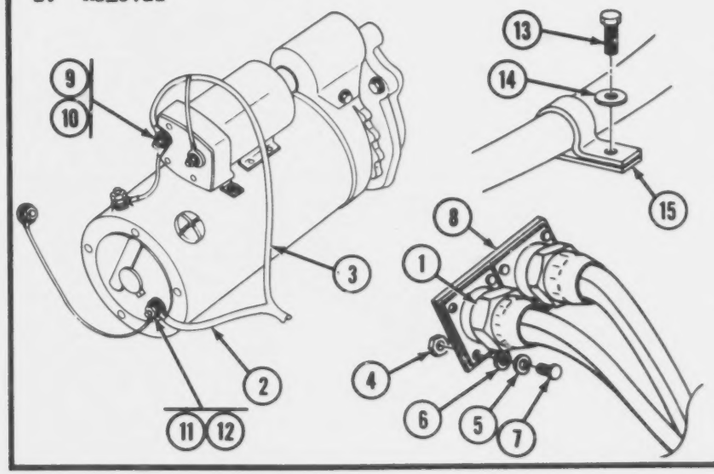
INITIAL SET-UP

Materials/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Engine disconnect bracket	
2.	Ground at starter	5A
3.	Starter solenoid	6A



a. Removal



1 Remove powerplant from hull (ref. p. 4-1).

2 Remove four nuts (4), four lockwashers (5), four washers (6), four screws (7) and connector (1) from engine electrical disconnect bracket (8).

3 Remove nut (9), washer (10) and electrical lead 6A (3). Reinstall nut and washer at starter solenoid.

4 Remove nut (11), washer (12) and ground lead 5A (2). Reinstall nut and washer at engine block.

5 Remove two screws (13). two washers (14), two clamps (15) and harness. Reinstall clamp and screws.

b. Disassembly/Repair

Disassemble harness in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

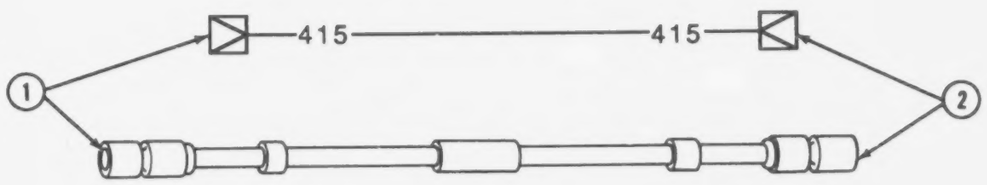
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-63. NBC SWITCH TO CIRCUIT BREAKER LEAD ASSEMBLY (12352790) - M109A4

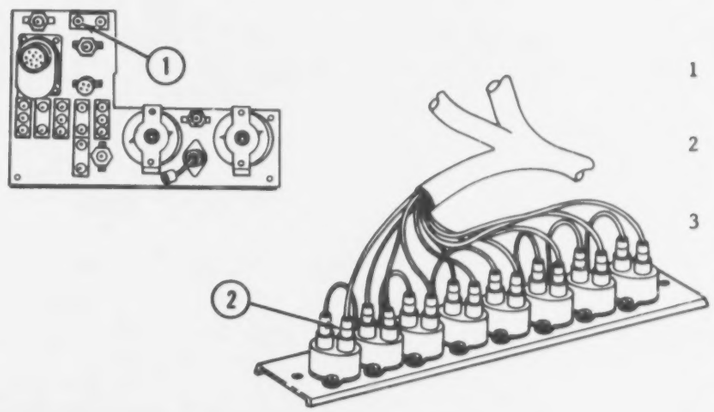
This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.	Connector Number	Electrical Lead To	Wire No.
1.	NBC switch	438	2.	Circuit breaker	438



a. Removal



1 Remove portable instrument panel (ref. p. 8-22).

2 Disconnect connector (1) from NBC switch socket.

3 Disconnect connector (2) wire 438 from circuit breaker panel.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

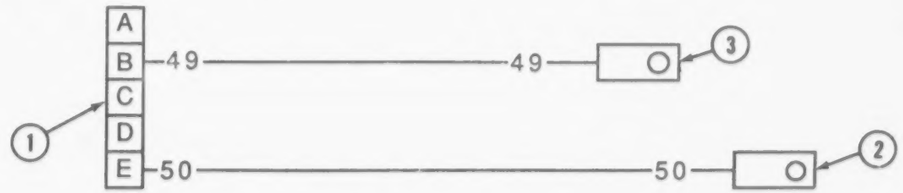
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

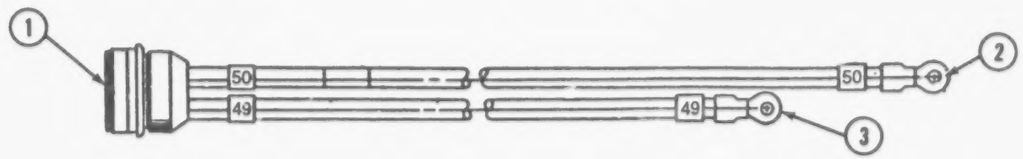
8-64. DRIVER'S BULKHEAD TO BATTERIES LEAD ASSEMBLY (12353402) - M109A4

This task covers:

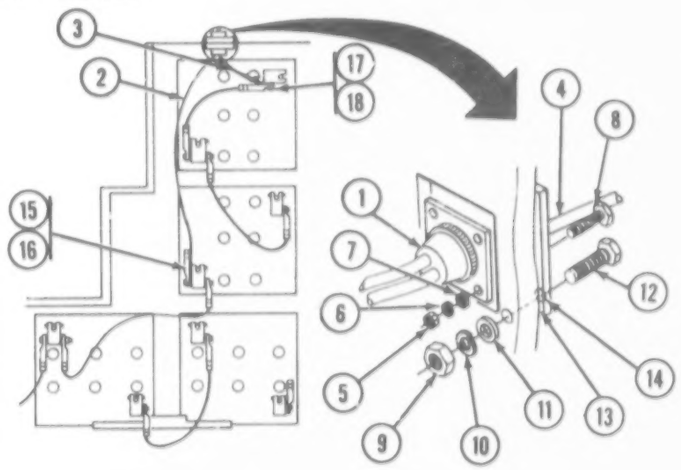
a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Driver's bulkhead	49, 50
2.	Battery positive lead	49
3.	Battery negative lead	50





a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Disconnect connector (4) on inside of driver's compartment.

3 Remove four nuts (5), four lockwashers (6), four flatwashers (7) and four screws (8) and disconnecc connector (1) from driver's bulkhead.

4 If replacement is necessary, remove four nuts (9), four lockwashers (10), four washers (11), four screws (12), gasket (13) and cover (14). Remove nut (15), bolt (16) and disconnect positive lead (2) from battery terminal.

5 Remove nut (17), bolt (18) and disconnect ground lead (3) from battery terminal.

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-65. ENGINE DISCONNECT BRACKET TO BATTERIES LEAD ASSEMBLY (12353401) - M109A4

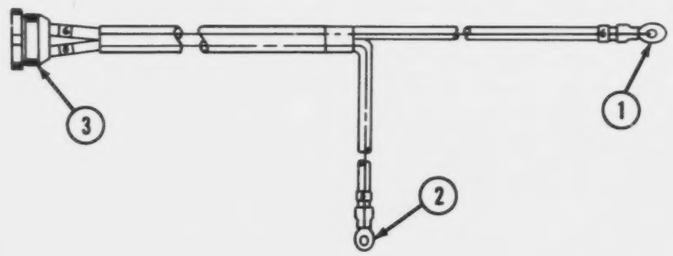
This task covers:

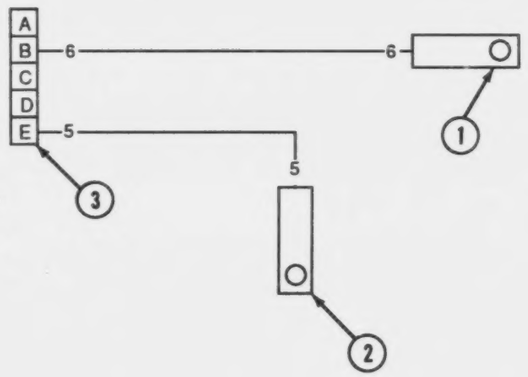
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

Material/Parts
Electrical tape (as required)

Connector Number	Electrical Lead To	Wire No.
1.	Battery positive lead	6
2.	STE/ICE Battery negative lead	5
3.	Engine bracket	





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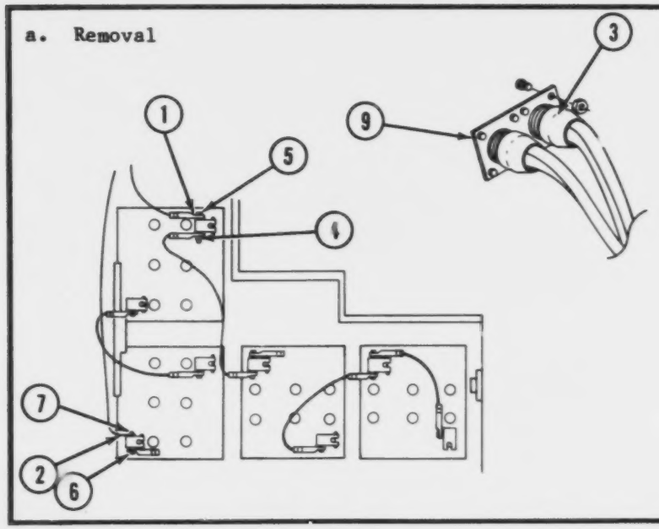
a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Remove nut (4), bolt (5) and disconnect positive lead (1) from battery.

3 Remove nut (6), bolt (7) and disconnect ground lead (2) from battery.

4 Disconnect connector (3) at engine bracket (9).

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-66. BULKHEAD TO OVERRIDE SWITCH LEAD ASSEMBLY (12268419) - M109A4

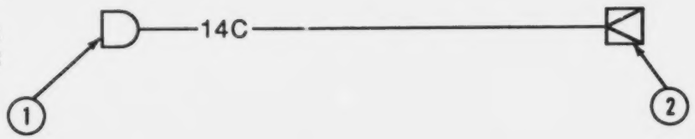
This task covers:

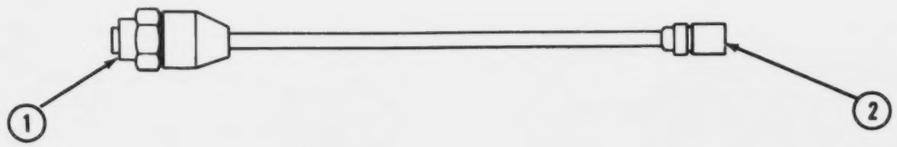
a. Removal b. Disassembly/Repair c. Assembly d. Installation

INITIAL SET-UP

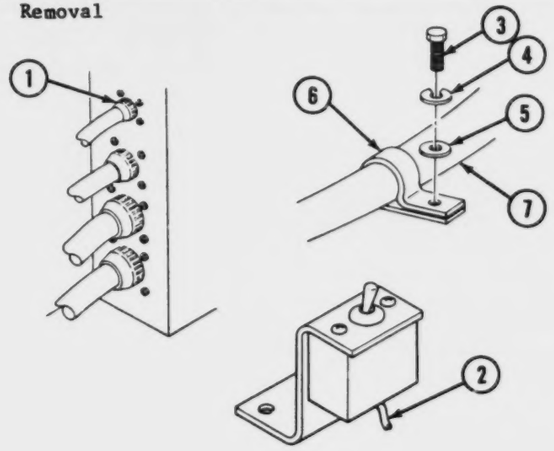
Material/Parts
Electrical tape - black (as required)

Connector Number	Electrical Lead To	Wire No.
1	Driver's Bulkhead	14C
2	Starter protection override switch	14C





a. Removal



1 Disconnect batteries (ref. p. 8-56).

2 Disconnect electrical connector (1) at driver's bulkhead.

3 Disconnect electrical connector (2) at combat override switch assembly.

4 Remove 14 screws (3), 14 lockwashers (4), 14 flatwashers (5), 14 straps (6) and lead assembly (7).

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

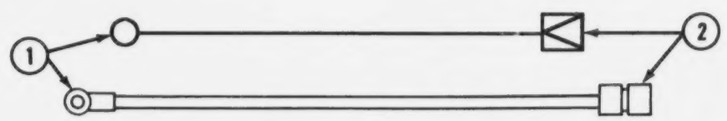
ELECTRICAL SYSTEM - SECTION IV. POWERPLANT AND HULL ELECTRICAL LEADS - CONTINUED

8-67. COMBAT OVERRIDE SWITCH GROUND LEAD (12353074) - M109A4

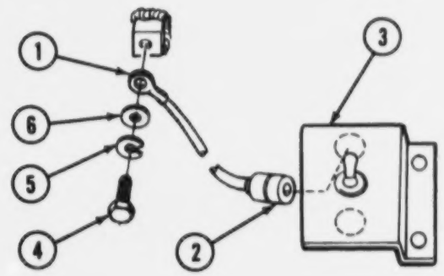
This task covers:

a. Removal b. Disassembly/Repair c. Assembly d. Installation

Connector Number	Electrical Lead To	Wire No.
1.	Ground	GND
2.	Combat override switch	GND



a. Removal



1 Disconnect connector (2) from override switch (3).

2 Remove screw (4), lockwasher (5), washer (6) and ground lead connector (1).

b. Disassembly/Repair

Disassemble in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

Install in reverse order of removal.

CHAPTER 9
TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES

GENERAL

This chapter provides operational checks, testing, adjustment, and component information for the transmission and transfer assemblies, and illustrates the procedures for removal, installation, disassembly, assembly and adjustment of the driving controls and linkages.

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TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION I. TRANSMISSION AND TRANSFER ASSEMBLIES

9-1. TRANSMISSION OIL LEVEL

The cross drive transmission is lubricated by oil. Low transmission oil level may be caused by leakage. Source of leakage must be determined and the condition corrected to avoid damage to transmission. Notify supporting maintenance personnel.

Check oil level before starting the engine (ref. TM 9-2350-311-10). After the engine starts, check lubricating oil pressure. The minimum oil pressure is 10 psi (0.7 Kg/cm^2) at 1000 rpm.

9-2. TRANSMISSION OIL PRESSURE CHECKS AND STALL TESTS

During the following tests, observe the oil pressure and oil temperature gages on portable instrument panel. The oil temperature should be approximately 220^{o}F (104^{o}C) for normal operation. If the oil temperature exceeds 300^{o}F (149^{o}C) in any of the tests, the engine should be stopped and the cause determined. Small variations in pressure from those given in table (p. 9-6) do not necessarily mean that malfunctions exist. Malfunctions will cause radical changes in pressure.

9-3. PRESSURE CHECKS

This task covers:

Pressure Checks

INITIAL SET-UP

Test Equipment	Personnel Required
Pressure gage assembly and tube (Item 2, App. B)	2

Pressure Checks

1 Park vehicle on level ground.

WARNING

Vehicle has no brakes when final drives are disconnected. Failure to securely block vehicle tracks could injure personnel or damage vehicle or other equipment if vehicle rolls out of control.

2 Place 12- by 12- by 24-inch (30.5- by 30.5- by 61-centimeter) wood block (or equivalent) under front and rear of each track.

3 Traverse cab to 90°.

4 Open and secure air intake grille.

5 Remove radiator fan access door (ref. p. 4-10).

6 Remove center front slope plate assembly (ref. p. 4-10).

7 Remove transmission access doors (ref. p. 4-11).

8 Check transmission oil level. Oil level must be between ADD and FULL marks on dipstick. Add or drain oil as necessary (ref. TM 9-2350-311-10).

9 Remove right and left universal joints (ref. p. 10-45).

10 Apply brakes.

11 Start engine and shift transmission into fourth gear.

CAUTION

If transmission oil temperature gets over 300°F (149°C) during any test, stop engine and trouble-shoot transmission

12 Run engine at 1200 to 1500 rpm for 3 to 8 minutes, or until transmission reaches about 220°F (104°C).

13 Shift transmission through all ranges several times.

14 Shift transmission to neutral (N).

15 Apply brakes.

16 Increase engine speed to 1350 (1200 to 1500) rpm.

17 Check transmission oil level. Oil level must be at FULL mark on dipstick.

18 Add or drain oil as necessary (ref. TM 9-2350-311-10).

19 During warmup period, check transmission for leaks.

20 Tighten loose bolts, plugs, hose fittings. Replace defective hoses. If leakage cannot be stopped, notify support maintenance and stop pressure tests.

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION I. TRANSMISSION AND TRANSFER ASSEMBLIES - CONTINUED

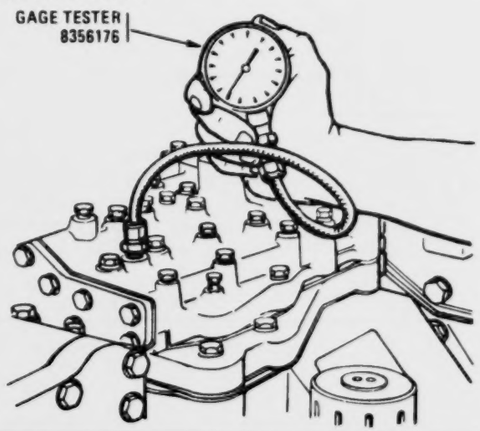
9-3. PRESSURE CHECKS - CONTINUED

WARNING

Transmission contains hot oil under high pressure. Stop engine before removing or installing pipe plugs and gage adapter in pressure test points. Install pipe plug as soon as gage adapter is removed. Remove only pipe plug at test point.

21 Stop engine.

22 Remove pipe plug from test point to be pressure tested.



23 Install pressure gage tester (Item 2, App. B).

24 Start engine.

25 Reduce engine speed to idle.

26 Shift transmission to desired range (ref. table, p. 9-6).

27 Slowly increase engine speed to desired rpm (ref. table, p. 9-6).

28 Record readings for each test point.

NOTE

When making steer clutch pressure tests, move steering bar slowly from horizontal to full steer in desired direction while watching pressure gage. Note pressure rise to maximum as steering bar moves to full steer.

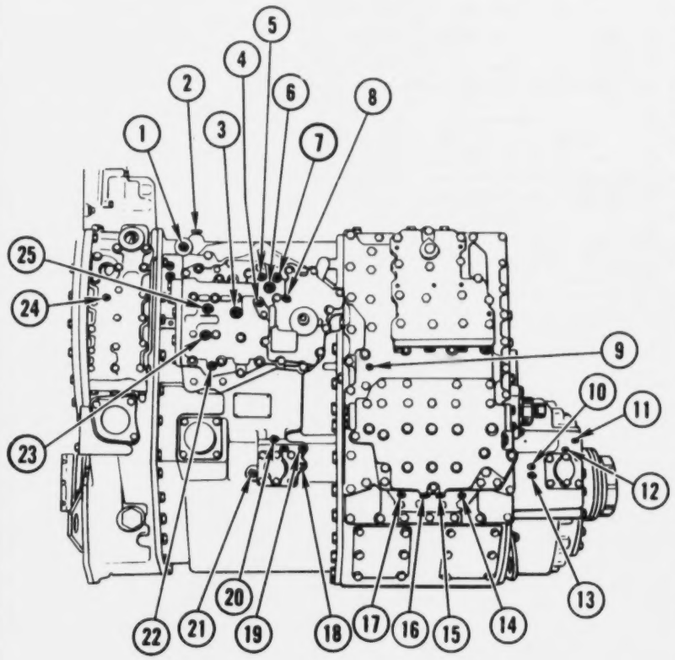
When making lockup engagement tests, increase engine speed slowly until lockup apply pressure is indicated on pressure gage. Record pressure and engine speed. Record governor pressure at lockup engagement.

TA472342

NOTE

When making lockup release tests, first increase engine speed higher than lockup engagement speed, then slowly reduce engine speed while watching pressure gage. When pressure drops quickly, record governor pressure and engine speed.

29 Install right and left universal joints (ref. p. 10-45).



LEGEND

1. Transmission lubrication
2. Transmission lubrication
3. Main
4. Third gear
5. Fourth gear
6. First and second gear
7. First, neutral, and reverse one signal pressure
8. Reverse
9. Reverse, third and fourth signal pressure
10. Geared steer clutch
11. Transmission lubrication
12. Geared steer coolant
13. Output clutch
14. Brake coolant
15. Brake
16. Brake
17. Brake coolant
18. Geared steer clutch
19. Geared steer coolant
20. Transmission lubrication
21. Output clutch
22. Throttle
23. Throttle valve
24. Lockup
25. Governor (pitot)

TA472343

Table 9-1. TRANSMISSION OIL PRESSURE

Test	Test Point No.	RPM	Reading lb/in² (kPa)	Neutral	1st Gear	2nd Gear	3rd Gear	4th Gear	Reverse 1	Reverse 2	Right steer	Left steer
Main pressure in converter	3	1000 to 1500	Normal	210 - 230 (1448 - 1586)	210 - 230 (1448 - 1586)	210 - 230 (1448 - 1586)	210 - 230 (1448 - 1586)	118 - 160 (814 - 1103)	300 - 320 (2069 - 2206)	300 - 320 (2069 - 2206)	Same as range reading	
			Actual									
Main pressure in lockup	3	1000 to 1500	Normal	118 - 160 (814 - 1103)	118 - 160 (814 - 1103)	118 - 160 (814 - 1103)	118 - 160 (814 - 1103)	160 - 190 (1103 - 1310)	160 - 190 (1103 - 1310)	160 - 190 (1103 - 1310)	Same as Range reading	
			Actual									
Lockup and range clutch apply pressure	24	1000 to 1500	Normal		Same as main pressure for applicable gear							
			Actual									
1st, neutral, and reverse 1 signal pressure	7	1000 to 1500	Normal		Same as main pressure for applicable gear							
			Actual									
3rd, 4th, and reverse 2 signal pressure	9	1000 to 1500	Normal		Same as main pressure for applicable gear							
			Actual									
Geared steer apply pressure (no steer)	10, 18	1000 to 1500	Normal	210 (1448)	210 (1448)	0	0	0	210 (1448)	0	0	0
			Actual									
Geared steer apply pressure (during steer)	10, 18	1000 to 1500	Normal	0	0	0	0	0	0	0	74 - 127 (510 - 876)	74 - 127 (510 - 876)
			Actual									
Brake apply pressure	15, 16	1000 to 1500	Normal	0	0	0	0	0	0	0	74 - 127 (510 - 876)	74 - 127 (510 - 876)
			Actual									
Geared steer and brake coolant pressure	12, 19, 14, 17, 9	1000 to 1500	Normal	0	0	0	0	0	0	0	8 - 12	8 - 12
			Actual									
Output clutch pressure	21	1000 to 1500	Normal	0	0	210 (1448)	210 (1448)	118 - 160 (814 - 1103)	0	210 (1448)	0*	0*
			Actual									
Governor pressure (pitot) at lockup engagement	25	Full throttle	Normal	82 - 88 (565 - 607)	82 - 88 (565 - 607)	82 - 88 (565 - 607)	82 - 88 (565 - 607)	82 - 88 (565 - 607)	82 - 88 (565 - 607)	82 - 88 (565 - 607)	82 - 88 (565 - 607)	82 - 88 (565 - 607)
			Actual									
Lubrication pressure	1, 2, 11 20	1835 to 1900	Normal	18 - 45 (124 - 310)	18 - 45 (124 - 310)	18 - 45 (124 - 310)	18 - 45 (124 - 310)	18 - 45 (124 - 310)	18 - 45 (124 - 310)	18 - 45 (124 - 310)	18 - 45 (124 - 310)	18 - 45 (124 - 310)
			Actual									
Throttle (T) pressure	22	Full throttle	Normal	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)
			Actual									
Throttle valve (TV) pressure	23	Full throttle	Normal	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)	32 - 40 (221 - 276)
			Actual									

*Clutch pressure can be measured only when steering bar is turned toward side being tested.

9-4. OIL FILTER AND OIL COOLER HOSES

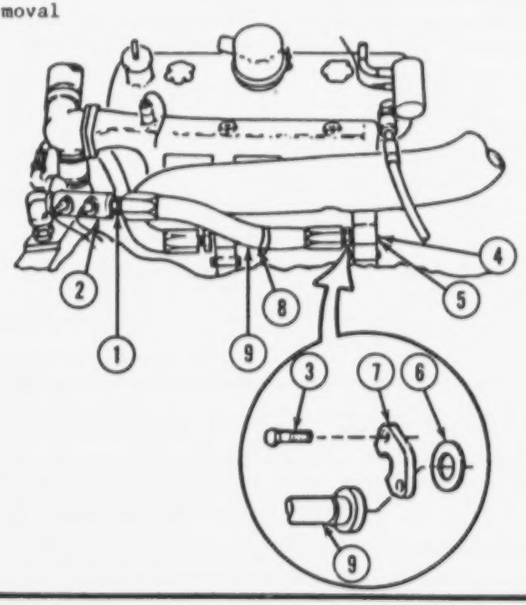
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Preformed packings (2)

a. Removal



WARNING

Be sure exhaust pipes are cool before removing hoses to avoid severe burns.

1 Remove powerplant (ref. p. 4-1).

2 Unscrew nut (1) from hose fitting (2) at manifold.

3 Remove four screws (3), four lockwashers (4), four nuts (5), preformed packing (6) and split flange (7). Remove hose clamp (8).

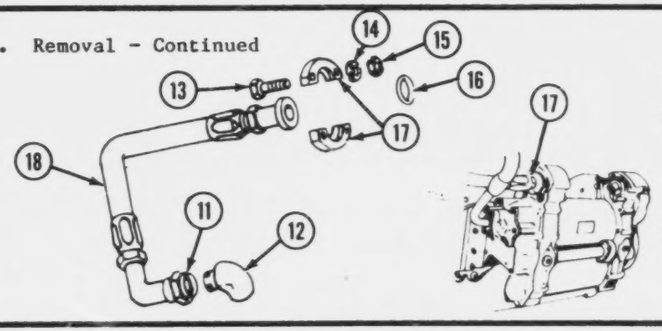
4 Remove transmission-to-transmission oil cooler hose (9). Discard preformed packing (8).

TA472344

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION I. TRANSMISSION AND TRANSFER ASSEMBLIES - CONTINUED

9-4. OIL FILTER AND OIL COOLER HOSES - CONTINUED

a. Removal - Continued

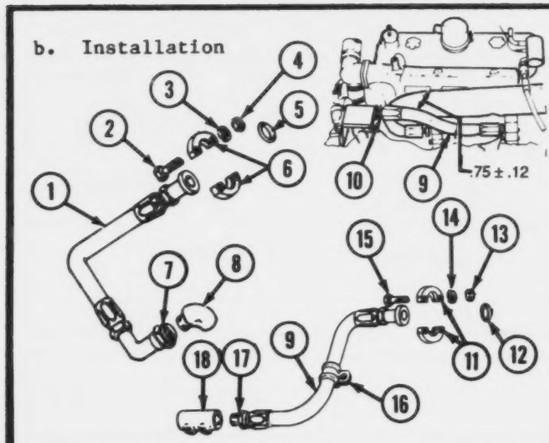


5 Unscrew nut (11) at elbow (12).

6 Remove four screws (13), four lockwashers (14), four nuts (15), preformed packing (16) and split flange (17). Discard preformed packing.

7 Remove transmission oil cooler-to-transmission hose (18).

b. Installation



1 Install transmission oil cooler-to-transmission hose (1).

2 Install four screws (2), four lockwashers (3), four nuts (4), preformed packing (5) and split flange (6). Replace preformed packing.

3 Screw on nut (7) at elbow (8).

4 Install transmission-to-transmission oil cooler hose (9), replacing preformed packing (10).

5 Install split flange (11), preformed packing (12), four nuts (13), four lockwashers (14), and four screws (15). Install hose clamp (16).

6 Install nut (17) in hose fitting (18) at manifold. Provide .75 ± .12 inch clearance between manifold and hose.

7 Install powerplant (ref. p. 4-1).

TA472345

9-5. OIL FILTER

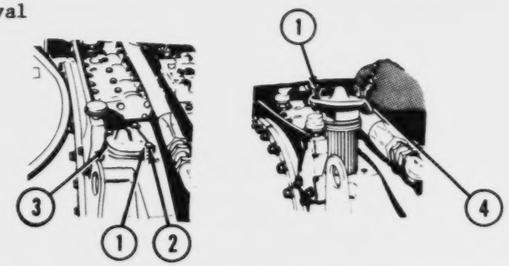
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Filter element
Preformed packing

a. Removal

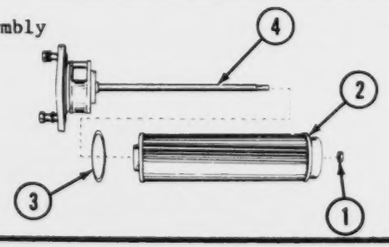


1 Remove front slope plate (ref. p. 4-10).

2 Remove three screws (1) and three lockwashers (2).

3 Lift up on oil filter (3) to remove. If filter cannot be removed by hand, install two screws (1) in puller screw holes (4) and lift using screws.

b. Disassembly



1 Remove nut (1).

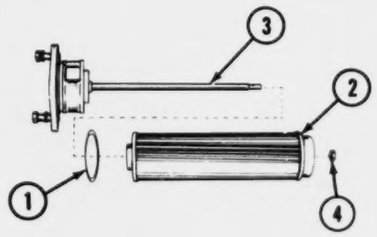
2 Separate filter element (2) and preformed packing (3) from rod assembly (4). Discard filter element (2) and preformed packing (3).

TA472346

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION I. TRANSMISSION AND TRANSFER ASSEMBLIES - CONTINUED

9-5. OIL FILTER - CONTINUED

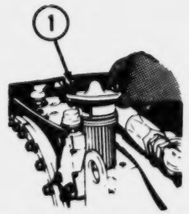
c. Assembly



1 Install new preformed packing (1) and new filter element (2) on rod assembly (3).

2 Install nut (4).

d. Installation



1 Position oil filter (1) into transmission.

2 Install three lockwashers (2) and three screws (3).

3 Install front slope plate (ref. p. 4-10).

TA472347

9-6. BREATHER TUBE AND MOUNT

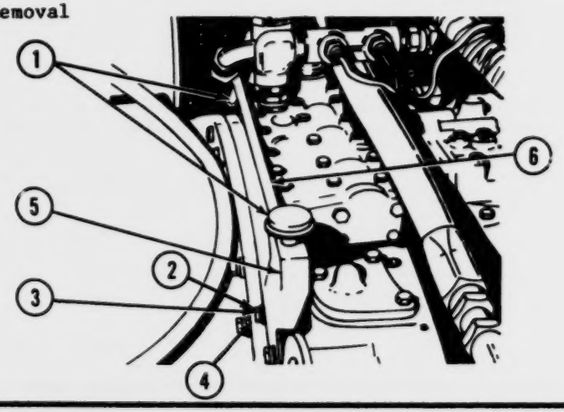
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Drycleaning solvent (Item 19, App. C)

a. Removal



NOTE

Breather tube can be removed without removal of mount.

1 Loosen two tube nuts (1) at mount end of tube and at elbow.

2 Loosen two screws (2), two lockwashers (3) and two flatwashers (4). Slide mount (5) towards front of vehicle and remove breather tube (6). Clean breather tube using solvent (Item 19, App. C).

3 Remove two screws (2), two lockwashers (3), two flatwashers (4) and mount (5).

b. Installation

1 Install mount (5) with two screws (2), two lockwashers (3) and two flatwashers (4), but do not tighten.

2 Install breather tube (6) and tighten nuts (1) then tighten two screws (2) on mount (5). TA472348

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES

9-7. STEERING CONTROL LINKAGE

This task covers:

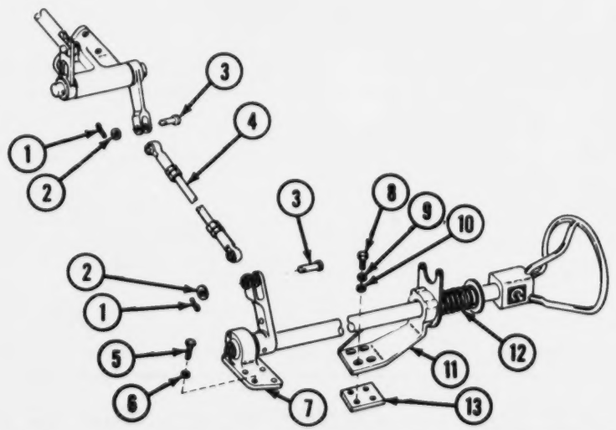
a. Removal b. Disassembly c. Assembly d. Installation e. Adjustment

INITIAL SET-UP

Materials/Parts
Lockwire, Cotter pins (2)

Personnel Required
2

a. Removal



NOTE

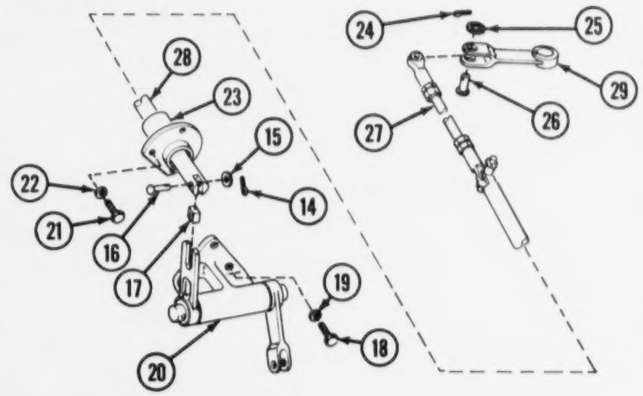
Rod end bearings used on various control linkages are of similar design and construction. For replacement of rod end bearings on any of the linkages, refer to illustration above. Inspect rod ends during adjustment procedures. Replace damaged or defective rod ends. Ensure witness hole is closed after adjustment is completed.

1 Remove master warning light assembly from steering shaft mount (ref. p. 8-134).

2 Remove two cotter pins (1), two flatwashers (2), two pins (3) and rod assembly (4). Rod assembly (4) is connector between steering shaft and bulkhead mounted housing.

TA472349

a. Removal - Continued



3 Remove four screws (5) and four lockwashers (6) from bracket (7), and four screws (8), four lockwashers (9) and four flatwashers (10) from bracket (11).

4 Remove steering shaft assembly (12) with two brackets (7) and (11) and spacer (13) from driver's compartment.

5 Remove cotter pin (14), flatwasher (15), pin (16) and swivel block (17) at adapter (23).

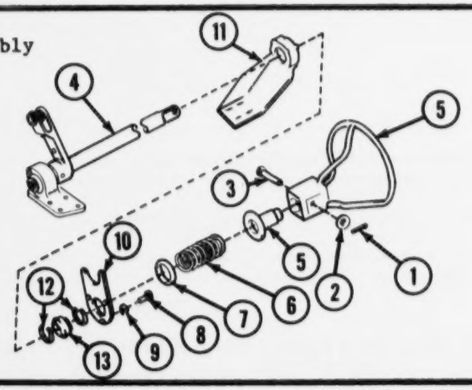
6 Remove three screws (18), three lockwashers (19) and housing assembly (with rod and levers) (20) at bulkhead.

7 Remove three screws (21), three lockwashers (22) and adapter (23) at bulkhead.

8 Remove cotter pin (24), flatwasher (25), pin (26), rod assembly (27) and shaft (28).

9 Remove lever (29) from transmission stud.

b. Disassembly



1 Remove cotter pin (1), flatwasher (2), pin (3) and steering wheel (5) from shaft (4).

2 Remove sleeve (5), spring (6) and washer (7) from shaft.

3 Remove three screws (8), three lockwashers (9) and master warning light bracket (10) from bracket (11).

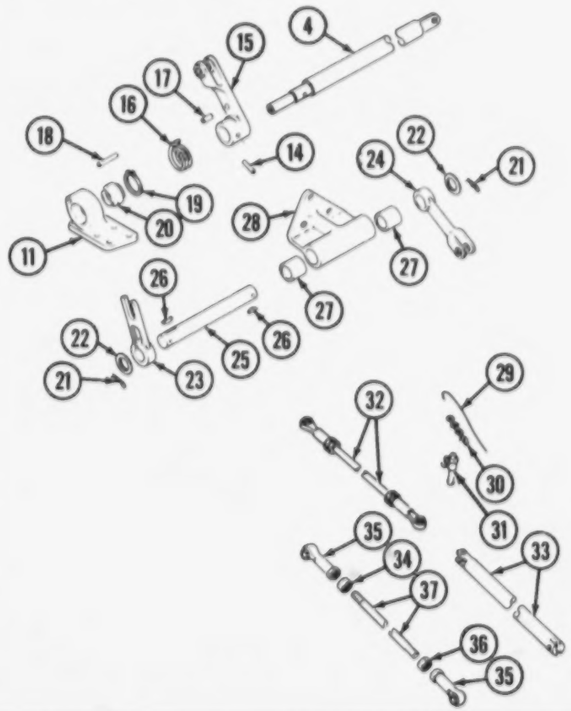
4 Remove two retaining rings (12), bearing (13) and bracket (11) from shaft (4).

TA472350

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-7. STEERING CONTROL LINKAGE - CONTINUED

b. Disassembly - Continued



5 Remove pin (14), lever (15) and spring (16) from shaft (4).

6 Remove pin (17) from lever (15). Lever holds spring (16) under tension.

7 Remove pin (18), retaining ring (19), bearing (20) and shaft (4) from bracket (11).

8 Remove two cotter pins (21), two flatwashers (22), lever (23) and lever (24) from shaft (25).

9 Remove shaft (25), two Woodruff keys (26) and two bearings (27) from housing (28).

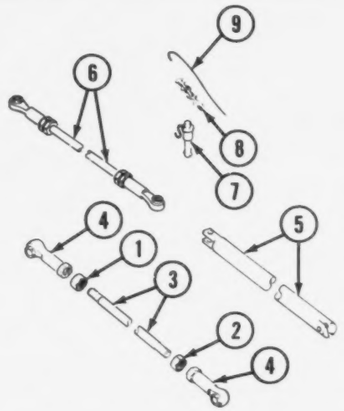
10 Remove wire (29), chain (30) and quick release pin (31).

11 Separate rod assembly (32) and shaft (33).

12 Loosen two nuts (34) at both ends of rod (37). Unscrew two rod ends (35) and two nuts (36) from rod.

TA472351

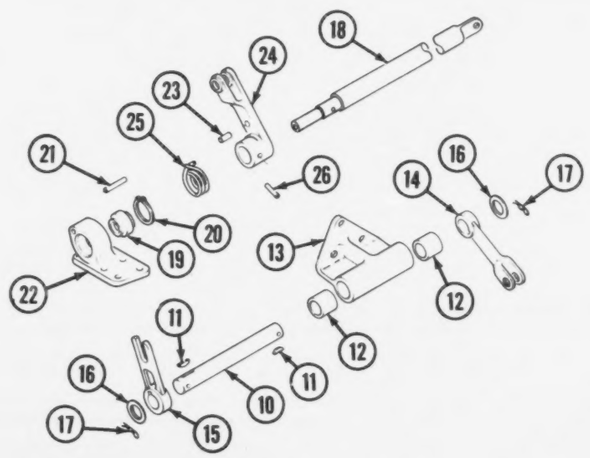
c. Assembly



1 Install nuts (1) and (2) on rod (3) and install two rod ends (4).

2 Reattach shaft (5) and rod assembly (6).

3 Install quick-release pin (7), chain (8) and wire (9).



4 Install shaft (10), two Woodruff keys (11) and two bearings (12) in housing (13).

5 Install lever (14) and other lever (15), two flatwashers (16) and two cotter pins (17) onto shaft (10).

6 Install shaft (18), bearing (19), retaining ring (20) and pin (21) onto bracket (22).

7 Install pin (23) into lever (24). Lever holds spring (25) under tension.

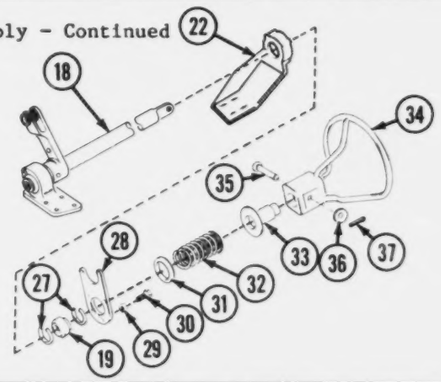
8 Install spring (25), lever (24) and pin (26) onto shaft (18).

TA472352

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-7. STEERING CONTROL LINKAGE - CONTINUED

c. Assembly - Continued



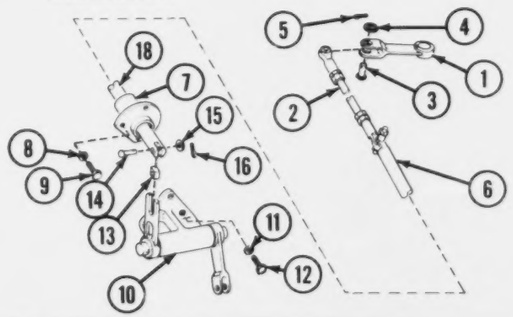
9 Install bracket (22) bearing (19) and two retaining rings (27) onto shaft (18).

10 Install master warning light bracket (28), three lockwashers (29) and three screws (30) onto bracket (22).

11 Install washer (31), spring (32) and sleeve (33) over shaft (18).

12 Install steering wheel (34), pin (35), flatwasher (36) and cotter pin (37) back onto shaft (18).

d. Installation



1 Install lever (1) onto transmission stud.

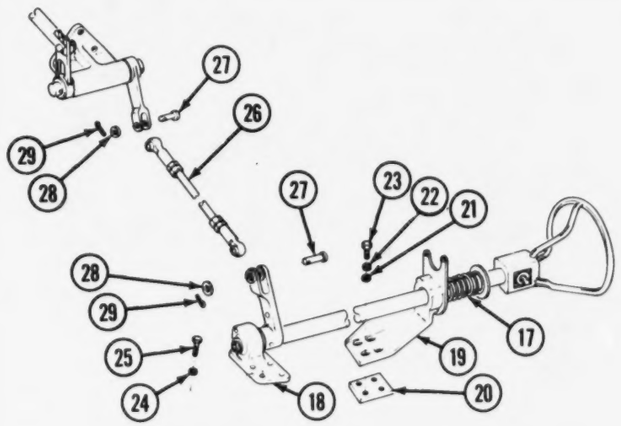
2 Install rod assembly (2), pin (3), flatwasher (4) and cotter pin (5) onto shaft (6).

3 Install adapter (7), three lockwashers (8) and three screws (9) at bulkhead.

4 Install housing assembly (w/rod and levers) (10), three lockwashers (11) and three screws (12) at bulkhead.

5 Install swivel block (13), pin (14), flatwasher (15) and cotter pin (16) at adapter (7).

TA472353



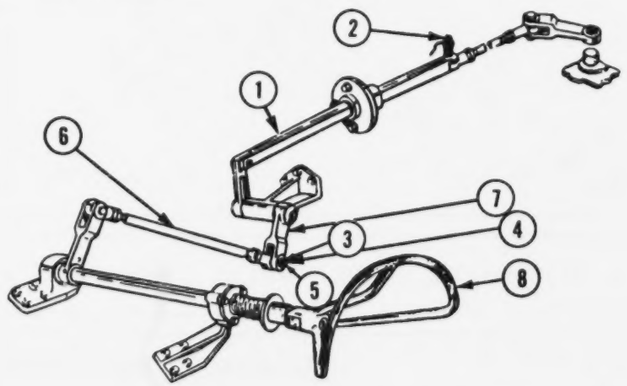
6 Install steering shaft assembly (17) with two brackets (18) and (19) and spacer (20) into driver's compartment.

7 Install four flatwashers (21), four lockwashers (22) and four screws (23) into bracket (19), and four lockwashers (24) and four screws (25) into other bracket (18).

8 Install rod assembly (26), two pins (27), two flatwashers (28) and two cotter pins (29). Rod assembly (26) is connected between steering shaft and bulkhead mounted housing.

9 Install master warning light assembly into steering shaft mount (ref. p. 8-134).

e. Adjustment



NOTE

Centerline of steering shaft rod lever must be in line with transmission shaft pointer.

1 Disconnect sliding steer shaft (1) by removing quick-disconnect pin (2).

2 Remove cotter pin (3), flatwasher (4) and clevis pin (5) to disconnect rod (6) from steer relay rear lever (7).

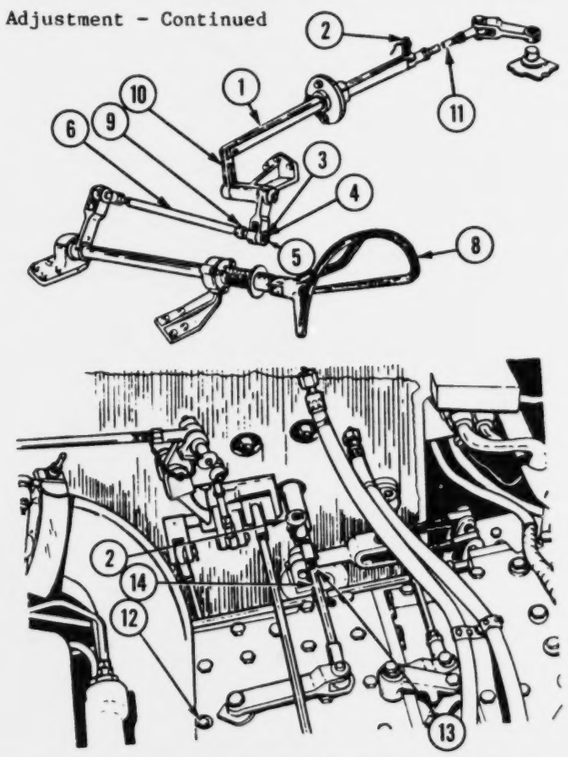
3 Place steering wheel (8) in its normal forward driving position (center spoke of steering wheel vertical).

TA472354

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-7. STEERING CONTROL LINKAGE - CONTINUED

e. Adjustment - Continued



4 Loosen rod end locknut (9) on the rod (6). Adjust rod length until steer relay front lever (10) is vertical (parallel to the adjacent bulkhead).

5 Replace clevis pin (5), flatwasher (4) and cotter pin (3), and tighten rod end locknut (9).

6 With transmission sliding steer shaft rod lever (11) in neutral steer position (pointer on transmission steer points to center mark on screw (12) and steering wheel in the normal driving position, loosen sliding steer shaft rod end locknut (13) and adjust rod until quick-disconnect pin (2) can be easily inserted through sliding steer shaft (14) with rod end in place.

7 Install quick-disconnect pin (2) and tighten sliding steer shaft rod end locknut (13).

NOTE

Check adjustment by turning steering wheel (8) and observing transmission sliding steer shaft rod lever (11). Lever should rotate in the opposite direction of the steering wheel to full right or left steer. Test drive vehicle. If any malfuctions exist, notify direct support maintenance.

TA472355

9-8. SHIFT CONTROL LINKAGE

This task covers:

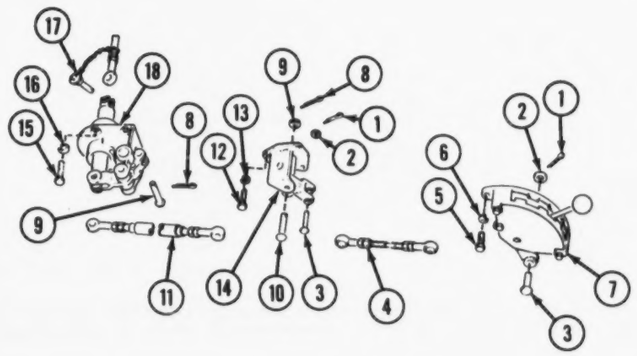
a. Removal b. Disassembly c. Assembly d. Installation e. Adjustment

INITIAL SET-UP

Materials/Parts
Cotter pins (6)

Personnel Required
2

a. Removal



1 Remove two cotter pins (1), two flatwashers (2), two pins (3) and shift control inner rod (4).

2 Remove three screws (5), three lockwashers (6) and shift control (7).

3 Remove two cotter pins (8), flatwasher (9), two pins (10) and shift control inner tube (11).

4 Remove three screws (12), three lockwashers (13) and support assembly (14).

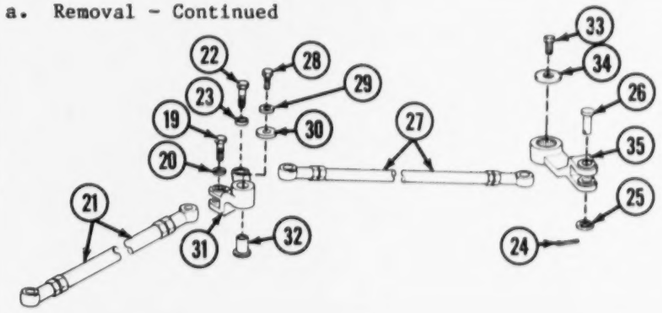
5 Remove four screws (15), four lockwashers (16), quick release pin (17) and base assembly with shaft (18). (Quick-release pin (17) is located in powerplant compartment at the bulkhead).

TA472356

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-8. SHIFT CONTROL LINKAGE - CONTINUED

a. Removal - Continued



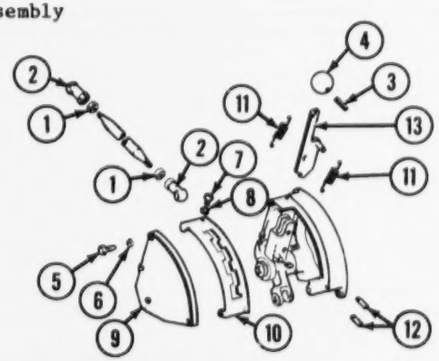
6 Remove screw (19), lockwasher (20) and shift control outer tube (21).

7 Remove screw (22), lockwasher (23), cotter pin (24), washer (25), pin (26) and shift control outer rod (27).

8 Remove screw (28), lockwasher (29), flatwasher (30), bellcrank (31) and spacer (32).

9 Remove screw (33), flatwasher (34) and lever (35).

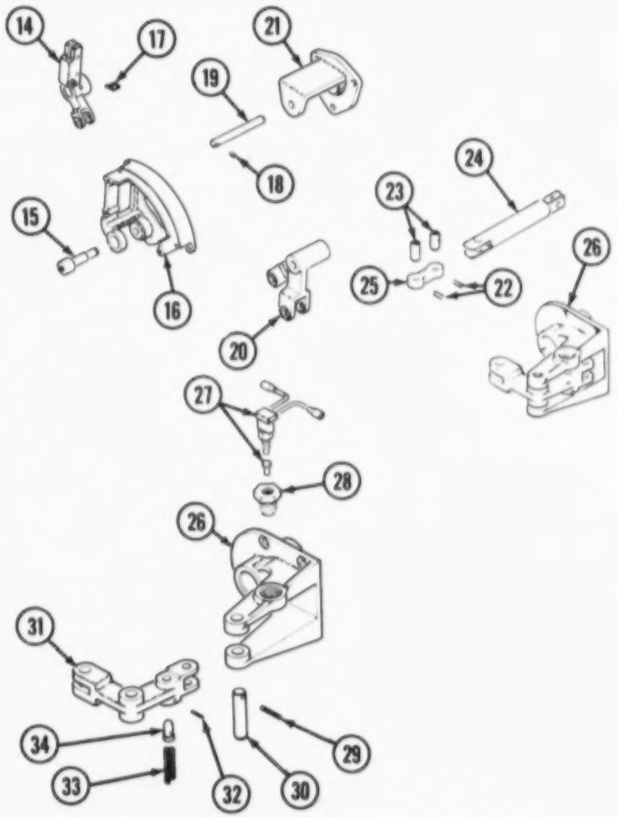
b. Disassembly



1 Loosen two locknuts (1).

2 Remove two rod ends (2) and two locknuts (1) from rod to disassemble tube and rod assemblies.

TA472357



3 To disassemble shift control, remove pin (3) and knob (4). Remove three screws (5), three lockwashers (6), two machine screws (7), two lockwashers (8), cover (9) and shift guide (10).

4 Remove two springs (11), two pins (12) and lever (13).

5 Remove lever (14) and shaft (15) from bracket (16). Remove grease fitting (17) from lever (14).

6 To disassemble support assembly and base assembly, remove pin (18), shaft (19) and bellcrank (20) from support (21).

7 Remove two pins (22), two shafts (23), shaft (24) and link (25) from base (26).

8 Remove neutral safety switch and pin (27) from adapter (28).

9 Remove adapter (28) from base (26).

10 Remove cotter pin (29), straight pin (30) and lever (31) from base (26).

11 Remove pin (32), spring (33) and contact pin (34) from lever (31).

c. Assembly

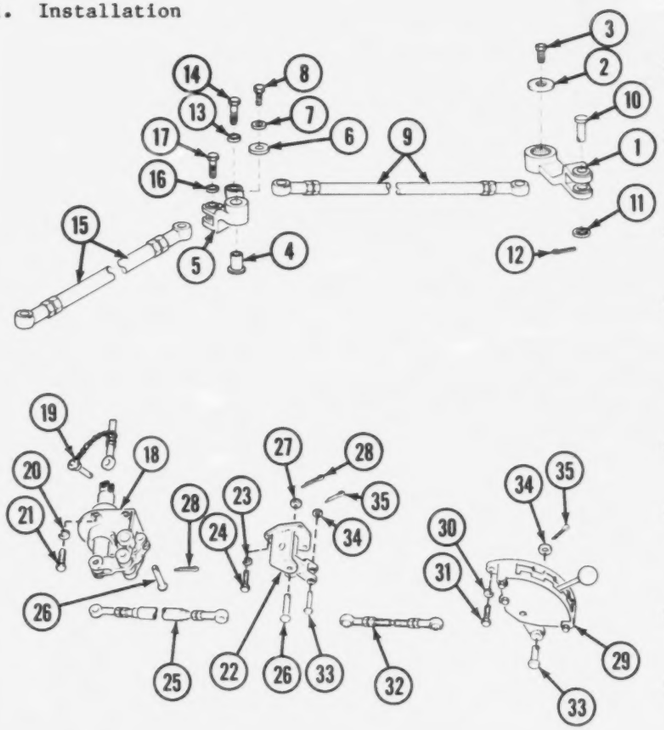
Assemble in reverse order of disassembly.

TA472358

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-8. SHIFT CONTROL LINKAGE - CONTINUED

d. Installation



1 Install lever (1), flatwasher (2) and screw (3).

2 Install spacer (4), bellcrank (5), flatwasher (6), lockwasher (7) and screw (8).

3 Install shift control outer rod (9), pin (10), washer (11), cotter pin (12), lockwasher (13) and screw (14).

4 Install shift control outer tube (15), lockwasher (16) and screw (17).

5 Install base assembly with shaft (18) by installing quick-release pin (19), lockwashers (20) and four screws (21). (Quick-release pin (19) is located in powerplant compartment at the bulkhead.)

6 Install support assembly (22), three lockwashers (23) and three screws (24).

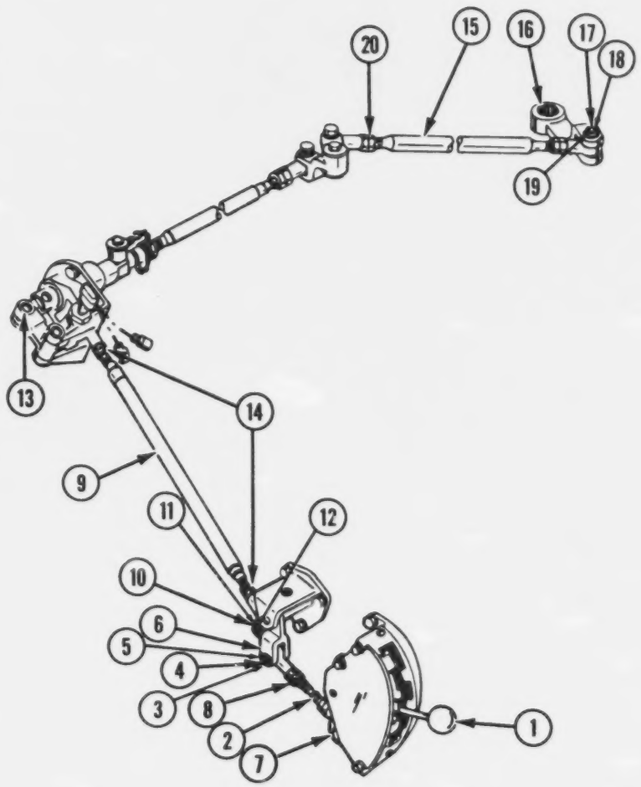
7 Install shift control inner tube (25), two pins (26), flatwasher (27) and two cotter pins (28).

8 Install shift control (29), three lockwashers (30) and three screws (31).

9 Install shift control inner rod (32), two pins (33), two flatwashers (34) and two cotter pins (35).

TA472359

e. Adjustment



1 Place shift control lever (1) in neutral (N) position. Disconnect shift control inner rod (2) by removing cotter pin (3), flatwasher (4) and clevis pin (5) from shift control inner bellcrank (6).

2 Place bellcrank (6) parallel with shift control arm (7).

3 Loosen nut (8) and adjust shift control inner rod (2) until clevis pin (5) can be installed easily. Install flatwasher (4) and cotter pin (3). Tighten nut (8).

4 Disconnect shift control inner tube (9) by removing cotter pin (10), flatwasher (11) and clevis pin (12).

5 With base lever (13) at neutral position on neutral safety switch (verify by attempting to crank engine while fuel shutoff is pulled) and with shift lever in neutral position, loosen nuts (14).

6 Adjust shift control inner tube (9) until clevis pin (12) can be easily inserted into lever of inner bellcrank.

7 Install flatwasher (11) and cotter pin (10). Tighten nuts (14) on shift control inner tube (9).

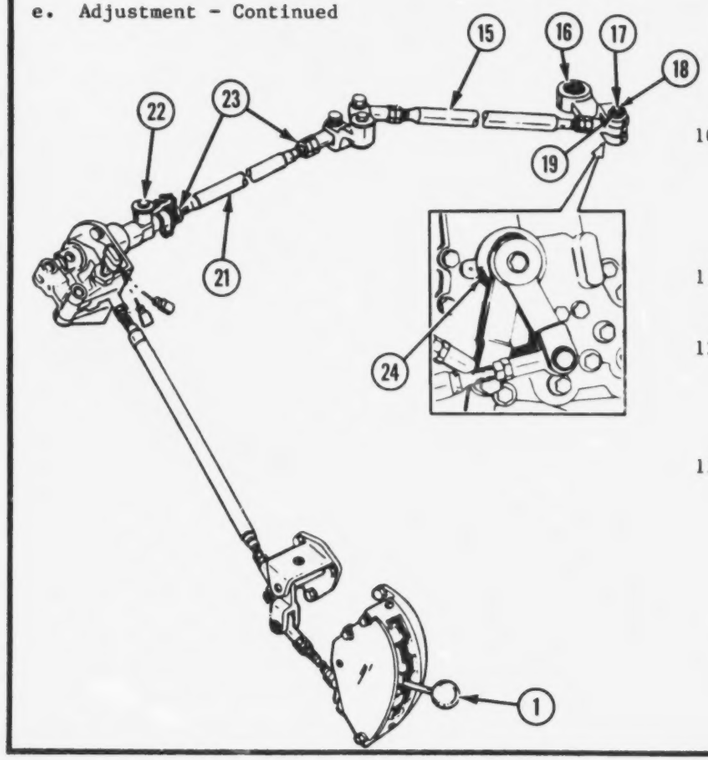
8 With shift control lever (1) in neutral (N) position, disconnect shift control outer rod (15) from transmission shift control lever (16) by removing cotter pin (17), flatwasher (18) and clevis pin (19).

9 Loosen nuts (20) and adjust rod to approximately 8-1/4 inches (21 cm) (centerline of bearing bore to centerline of bearing bore). Tighten nuts (20). TA472360

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-8. SHIFT CONTROL LINKAGE - CONTINUED

e. Adjustment - Continued



10 Disconnect shift control outer tube (21) by pulling quick-disconnect pin (22). Make sure control lever (1) is in neutral position and install shift control outer rod (15) in transmission shift control lever (16).

11 Install clevis pin (19), flatwasher (18) and cotter pin (17).

12 Loosen nuts (23) and adjust shift control outer rod (21) until quick-disconnect pin (22) can be easily inserted. Tighten nuts (23) on shift control outer rod (21).

13 Move shift control lever (1) through all positions. In each position, check to see that transmission shift control lever index (24) (located under shift control lever at transmission) indicates the same as the shift control lever position.

TA472361

9-9. SERVICE AND PARKING BRAKE LINKAGE

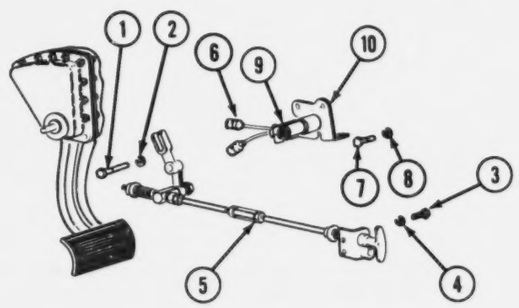
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation e. Adjustment

INITIAL SET-UP

Materials/Parts
Cotter pins (7), Boot,
Seals (2), Gasket

a. Removal



1 For parking brake removal, remove screw (1) and lockwasher (2).

2 Support parking brake linkage (5) and remove two screws (3) and two lockwashers (4).

3 Pull bellcrank at screw (1) off bracket spindle and remove parking brake linkage assembly (5).

4 Disconnect electrical connector (6).

5 Remove two screws (7), two lockwashers (8), parking brake light switch (9) and bracket (10).

TA472362

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

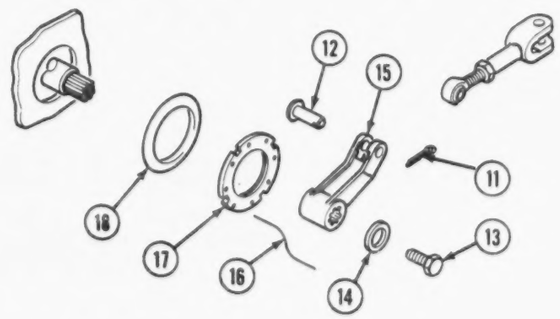
9-9. SERVICE AND PARKING BRAKE LINKAGE - CONTINUED

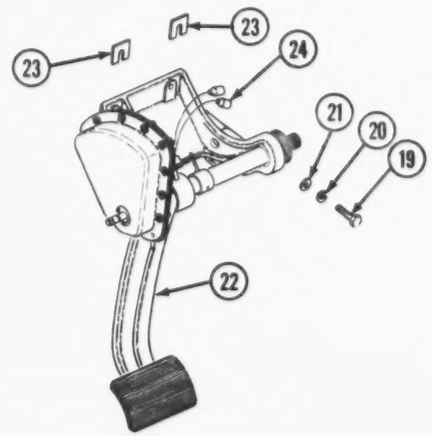
a. Removal - Continued

6 Through access to powerplant compartment, remove cotter pin (11) and pin (12).

7 Remove screw (13), flatwasher (14) and lever (15) from shaft. For removal of clevis, chain sprocket and brake apply levers, ref. p. 9-29.

8 Remove lockwire (16). Unscrew retainer plate (17) from end of bracket.





TA472363

a. Removal - Continued

NOTE

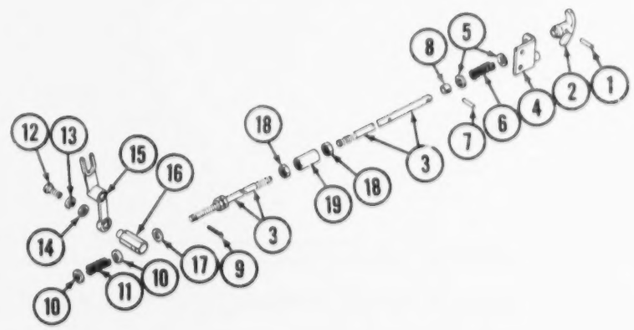
Brake assembly may be removed without removing seal (18) or before removing seal (18).

9 Remove seal (18).

10 Remove four screws (19), four lockwashers (20) and four flatwashers (21) from driver's bulkhead. Disconnect two electrical connectors (24) at brake warning light switch.

11 Remove brake assembly (22) and shims (23).

b. Disassembly



1 Remove pin (1) and T-handle (2) from end of rod (3).

2 Remove mounting bracket (4), two flatwashers (5) and spring (6).

3 Remove pin (7) and collar (8). Remove cotter pin (9), two flatwashers (10) and spring (11).

4 Remove screw (12), lockwasher (13), flatwasher (14), bellcrank (15) and rod guide (16) from rod.

5 Remove flatwasher (17).

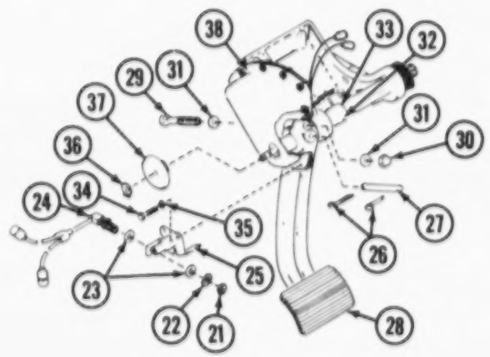
6 Remove two locknuts (18). Loosen and unscrew rod (3) ends from nut (19). (Removal of locknuts (18) from rod ends is not necessary.)

TA472364

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-9. SERVICE AND PARKING BRAKE LINKAGE - CONTINUED

b. Disassembly - Continued



7 For disassembly of parking light switch and bracket, unscrew and remove nut (21), lockwasher (22) and two flatwashers (23).

8 Separate parking brake light switch (24) and bracket (25).

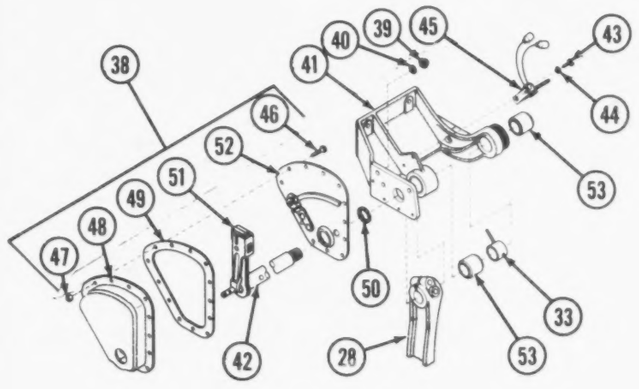
9 Remove two cotter pins (26) and pin (27) at brake pedal (28).

10 Remove screw (29), nut (30) and two flatwashers (31) at brake pedal.

11 Loosen two set screws (32) at actuator (33) and attach to bearing (53).

12 Remove two screws (34), two lockwashers (35), lock ring (36) and boot (37) at parking brake latch assembly (38).

TA472365



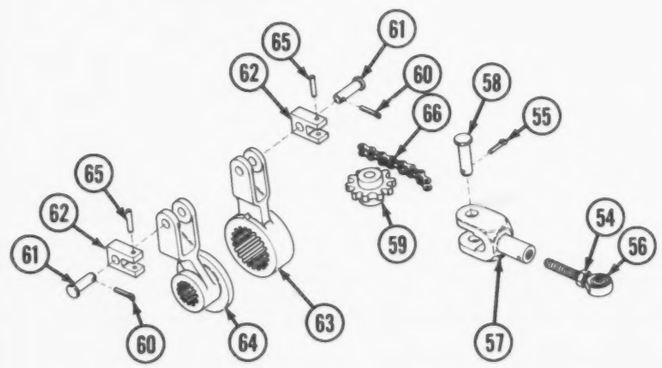
13 Remove three nuts (39) and three lockwashers (40) at support bracket (41).

14 Withdraw parking brake latch assembly (38), and shaft (42) from support bracket (41) to release actuator (33) and brake pedal (28).

15 Remove two screws (43), two lockwashers (44), bracket with stoplight switch (45) and two bearings (53) from support bracket (41).

16 Remove ten screws (46), ten nuts (47), cover (48), gasket (49) and seal (50).

17 Remove latch (51) and shaft (52) from latch plate (52).



18 Loosen locknut (54).

19 Remove cotter pin (55) and unscrew end (56) and clevis (57).

20 Remove pin (58) and sprocket (59) (with chain) from clevis (57).

21 Remove two cotter pins (60), two pins (61) and two clevises (62) (with chain) from right brake lever (63) and left brake lever (64).

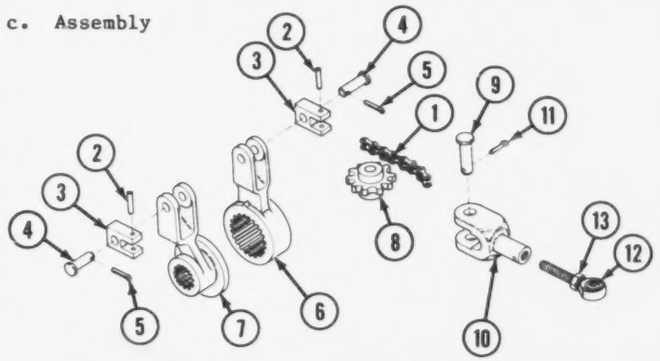
22 Remove two pins (65) and separate chain (66) from two clevises (62).

TA472366

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-9. SERVICE AND PARKING BRAKE LINKAGE - CONTINUED

c. Assembly



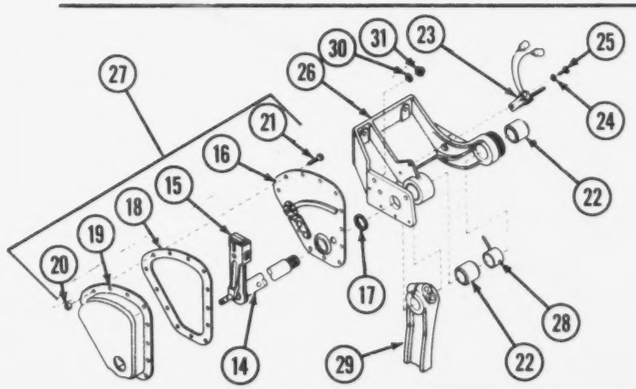
1 Install separate chain (1) and two pins (2) into two clevises (3) to assemble brake linkage.

2 Install two clevises (3) (with chain), two pins (4) and two cotter pins (5) onto right brake lever (6) and left brake lever (7).

3 Install sprocket (8) (with chain) and pin (9) into clevis (10).

4 Install cotter pin (11) and screw end (12) into clevis (10).

5 Tighten locknut (13).

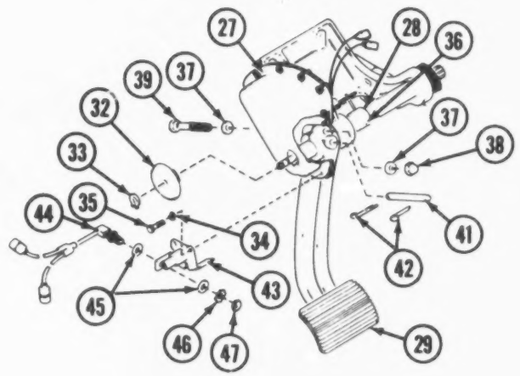


6 Insert shaft (14) (with installed latch (15)) into latch plate (16) to assemble brake assembly.

7 Install seal (17), gasket (18), cover (19), ten nuts (20) and ten screws (21).

8 Install two bearings (22), bracket with stoplight switch (23), two lockwashers (24), and two screws (25) into support bracket (26).

TA472367



9 Install shaft support bracket (26) and insert parking brake latch assembly (27) to tighten actuator (28) and brake pedal (29).

10 Install three lockwashers (30) and three nuts (31) at support bracket (26).

11 Install boot (32), lockring (33), two lockwashers (34) and two screws (35) at parking brake latch assembly (27).

12 Tighten two sets of screws (36) at actuator (28).

13 Install two flatwashers (37), nut (38) and screw (39) at brake pedal (29).

14 Install pin (41) and two cotter pins (42) at brake pedal (29).

15 To assemble parking brake light switch and bracket, connect bracket (43) and brake light switch (44).

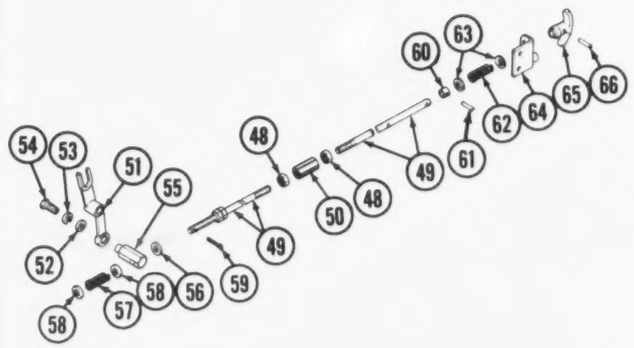
16 Install two flatwashers (45), lockwasher (46) and nut (47).

TA472368

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-9. SERVICE AND PARKING BRAKE LINKAGE - CONTINUED

c. Assembly - Continued



17 To assemble brake linkage, install two locknuts (48) on rods (49) and screw rods onto nut (50). Tighten locknuts against nut.

18 Assemble bellcrank (51), flatwasher (52), lockwasher (53) and screw (54) to rod guide (55).

19 Install flatwasher (56), rod guide (55), spring (57), two flatwashers (58) and cotter pin (59).

20 Install collar (60), pin (61), spring (62), two flatwashers (63) and mounting bracket (64).

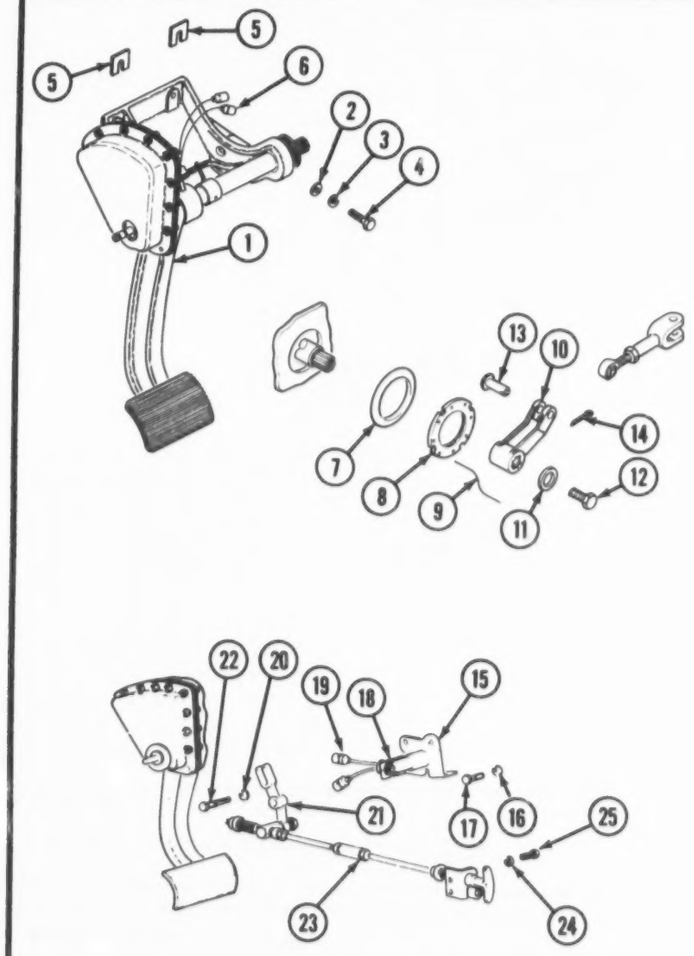
21 Install T-handle (65) and pin (66) at end of rod (49).

d. Installation

1 Install brake assembly (1) with four flatwashers (2), four lockwashers (3) and four screws (4). Install shims (5) as required.

2 Reconnect two electrical connectors (6) at brake warning light switch.

TA472369



3 Insert seal (7).

4 Screw on retainer plate (8) on end of bracket. Install lockwire (9).

5 Install lever (10), flatwasher (11) and screw (12) onto shaft. (For installation of clevis chain, sprocket, and brake apply levers, ref. p. 9-30.)

6 Install pin (13) and cotter pin (14) through powerplant compartment access.

7 Install bracket (15) with two lockwashers (16) and two screws (17). Install parking brake light switch (18) and reconnect electrical connector (19).

8 To install parking brake, place lockwasher (20) and bellcrank (21) on screw (22) and screw onto bracket spindle, installing parking brake linkage assembly (23).

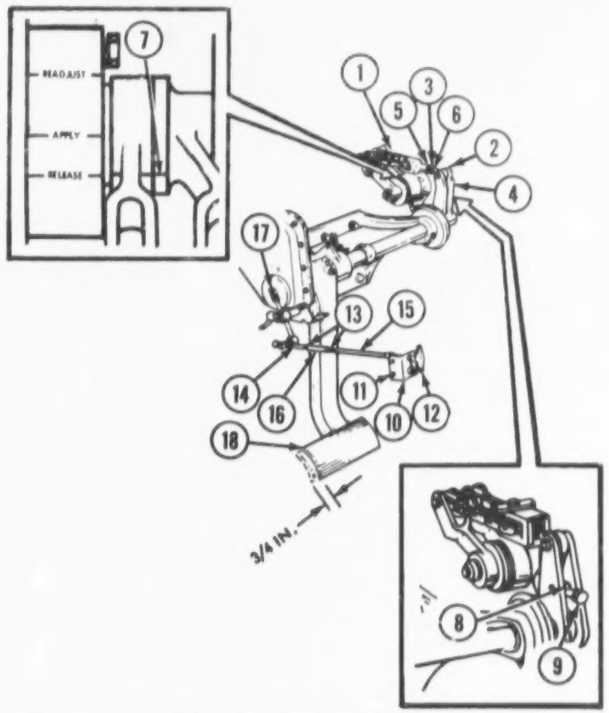
9 Install two lockwashers (24), and two screws (25), securing support of the parking brake linkage (23).

TA472370

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-9. SERVICE AND PARKING BRAKE LINKAGE - CONTINUED

e. Adjustment



1 Release service brake. Check for slack in the sprocket control chain (1). If no slack is present, go to step 2. If slack is present, remove cotter pin (2) and clevis pin (3) from brake shaft lever (4). Loosen locknut (5) and turn rod (6) clockwise to shorten. Replace pin (3) and check for slack again. If slack is still present, repeat the above. If no slack is present, go to step 2.

2 Check to ensure alignment of brake apply shaft index mark with release point (7). If linkage alignment is correct, go to step 3. If not aligned, adjust the length of rod (6) until they are aligned.

3 After brake adjustment, loosen locknut (8) on brake pedal lever stop screw (9). Adjust brake shaft lever stop screw (9) so that pedal has 3/4-inch (19 mm) free travel. Tighten locknut (8).

4 Loosen parking brake bracket (10) by removing screws and lockwashers (11).

5 Unlock parking brake handle (12) (up position). Loosen two nuts (13) on forward brake control rod (14) and rear brake control rod (15).

TA472371

6 Turn connecting nut (16) in either direction until holes in parking brake bracket (10) align with mating holes (hidden), and with no pressure on bellcrank (17).

7 Secure bracket to hull with two screws and two lockwashers (11). Tighten two locknuts (13) on each of control rods (14 and 15).

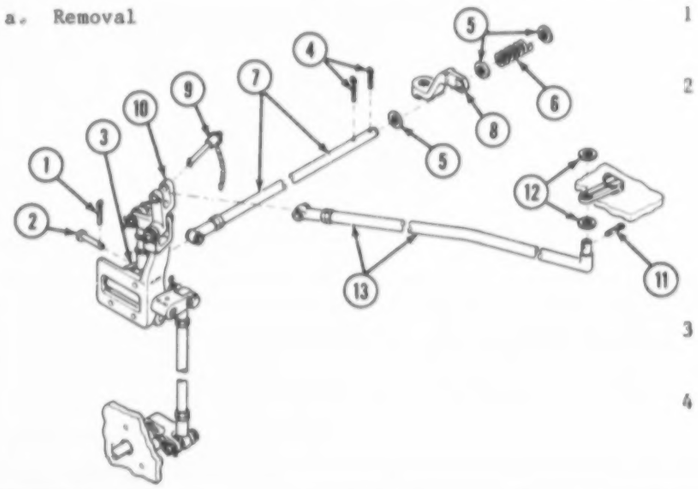
8 Depress brake pedal (18). Pull back on parking brake handle (12). Remove foot from pedal. Brake should stay locked. To release parking brakes, lift up and in on parking brake handle; then depress and release brake pedal.

9-10. ACCELERATOR, THROTTLE AND ENGINE CONTROL GOVERNOR

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

a. Removal



1 Remove cotter pin (1) and pin (2) at bellcrank (3).

2 Remove two cotter pins (4), three flatwashers (5), spring (6) and rod assembly (7) from throttle control lever (8).

NOTE

Remove throttle control lever (8) if damaged or requiring replacement at transmission.

3 Remove quick-release pin (9) at bellcrank (10).

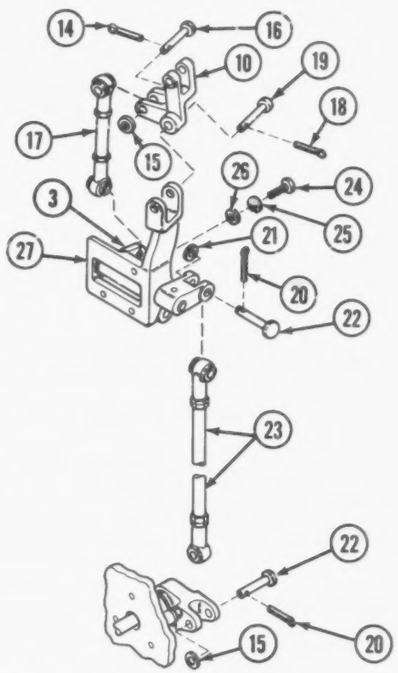
4 Remove cotter pin (11) and flatwashers (12) from end of governor control rod assembly (13).

TA472372

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-10. ACCELERATOR, THROTTLE AND ENGINE CONTROL GOVERNOR - CONTINUED

a. Removal - Continued



5 Remove two cotter pins (14), two flatwashers (15) and two pins (16) at bellcrank (10) and bellcrank (3) to remove rod assembly (17).

6 Remove rod assembly (17).

7 Remove cotter pin (18) and pin (19) at bellcrank (10).

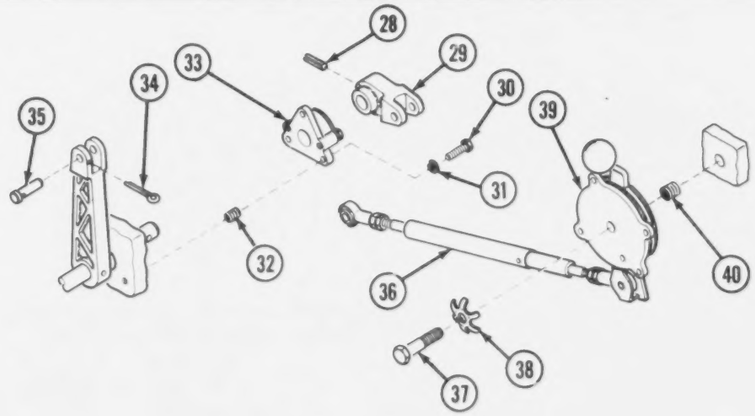
8 Remove bellcrank (10).

9 Remove two cotter pins (20), two flatwashers (21) and two pins (22) at rod assembly (23).

10 Remove rod assembly (23).

11 Remove three screws (24), three lockwashers (25), three flatwashers (26) and bracket assembly (27) from hull bulkhead.

TA472373



12 Remove pin (28) and remove lever (29).

NOTE

Remove inserts (32) and (40) only if threads are damaged and inserts must be replaced.

13 Remove three screws (30), three lockwashers (31), and three inserts (32) at bracket support assembly (33).

14 Remove bracket support assembly (33) from bulkhead.

15 For removal of linkage in driver's compartment, remove cotter pin (34) and pin (35) at end of throttle control rod (36).

NOTE

Throttle control rod (36) is part of hand throttle control assembly (39).

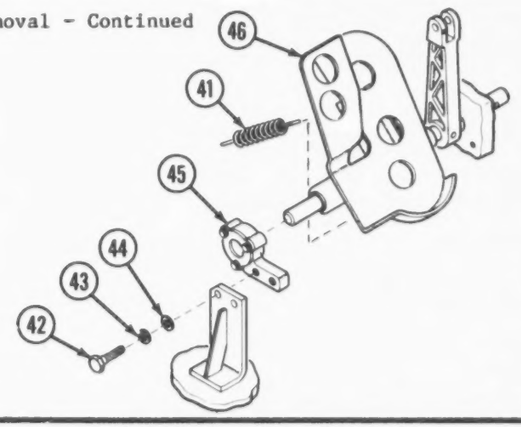
16 Remove throttle control assembly (39) by removing screw (37) and star spring washer (38). Remove insert (40) if necessary.

TA472374

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-10. ACCELERATOR, THROTTLE AND ENGINE CONTROL GOVERNOR - CONTINUED

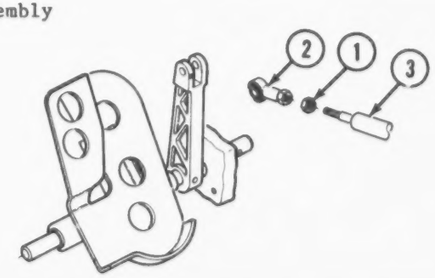
a. Removal - Continued



17 Remove pedal and shaft assembly (46) by removing spring (41), two screws (42), two lockwashers (43) and two flatwashers (44) at support bracket (45).

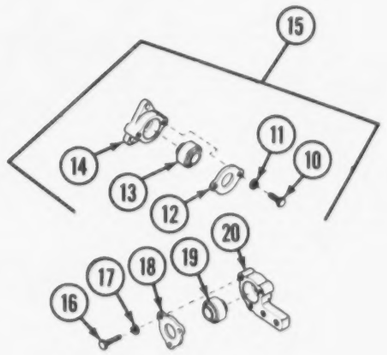
18 Twist assembly to clear bracket and withdraw from bulkhead bore to remove.

b. Disassembly



1 Disassemble rod assemblies by loosening nut (1) and removing after unscrewing rod ends (2) from shaft (3).

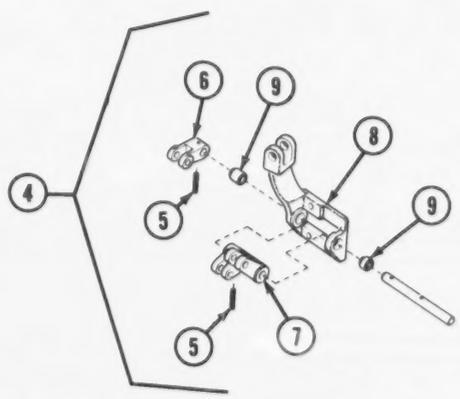
TA472375



2 Disassemble bracket assembly (4) by removing two pins (5). Then remove lever (6) and bellcrank (7) by pulling out the shaft from bracket (8). Remove bearings (9) if damaged or worn.

3 Disassemble bracket support assembly (15) by removing two screws (10) and two lockwashers (11). Remove cap (12) and bearing (13) from bracket (14).

4 Remove three screws (16) and three lockwashers (17). Remove cap (18) and bearing (19) from bracket (20).

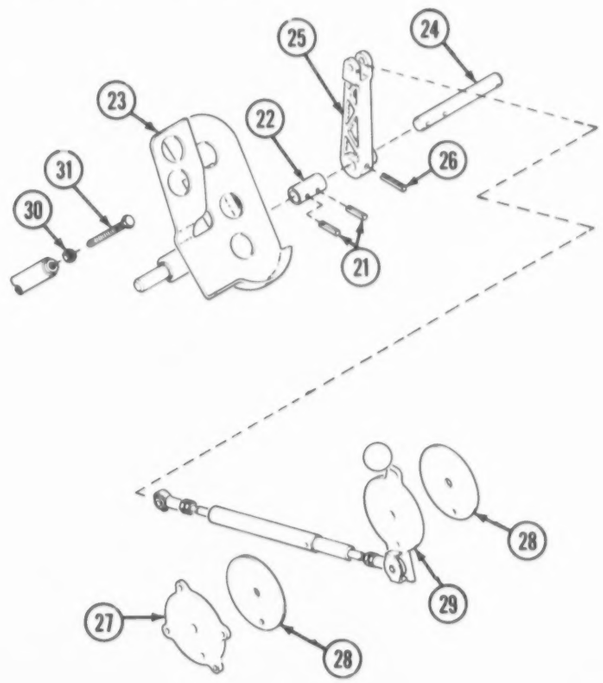


TA472376

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-10. ACCELERATOR, THROTTLE AND ENGINE CONTROL GOVERNOR - CONTINUED

b. Disassembly - Continued



5 Remove two pins (21), collar (22) and pedal (23) from shaft (24).

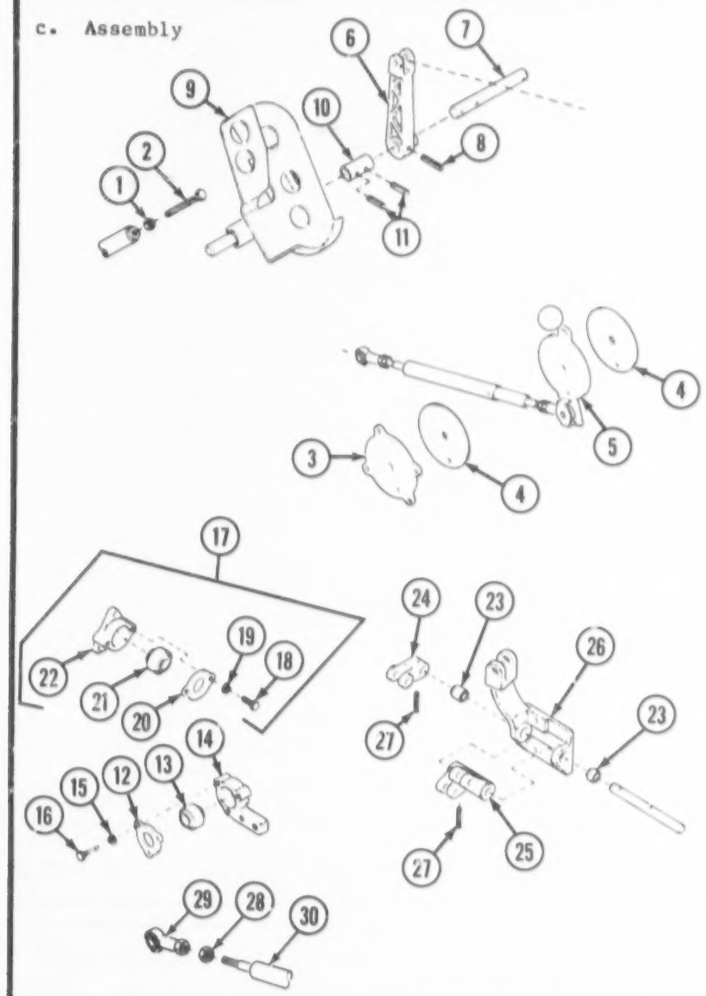
6 Separate shaft (24) from lever (25) by removing pin (26).

7 To disassemble hand throttle control assembly, separate cover (27), two disks (28) and lever with rod assembly (29).

8 Disassemble pedal stop by loosening nut (30) and removing screw (31) and locknut (30) from support. Unscrew locknut (30) from screw (31).

TA472377

c. Assembly



1 Screw locknut (1) onto screw (2). Assemble pedal stop by installing locknut (1) and screw (2), and tightening nut (1) onto support.

2 To assemble hand throttle control assembly, attach cover 93), two disks (4) and lever with rod assembly (5).

3 Attach lever (6) to shaft (7) by installing pin (8).

4 Install pedal (9), collar (10) and two pins (11) onto shaft (7).

5 Install cap (12) and bearing (13) onto bracket (14). Install three lockwashers (15) and three screws (16).

6 Assembly bracket support assembly (17) by first installing bracket from accelerator pedal shaft.

7 Assemble bracket support assembly (17) by installing two screws (18) and two lockwashers (19). Install cap (20) and bearing (21) from bracket (22).

8 To install bracket assembly, replace bearing (23) if damaged. Then install the lever (24) and bellcrank (25) by pushing the shaft into the bracket (26). Finally, install two pins (27).

9 To assemble rod assemblies, install nut (28) and tighten after screwing rod ends (29) onto shaft (30).

TA472378

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-10. ACCELERATOR, THROTTLE AND ENGINE CONTROL GOVERNOR - CONTINUED

d. Installation

1 Install throttle control assembly (1) by installing screw (2) and star spring washer (3). Install insert (4) if necessary.

2 For installation of linkage in driver's compartment, install pin (5) and cotter pin (6) at end of throttle control rod (7).

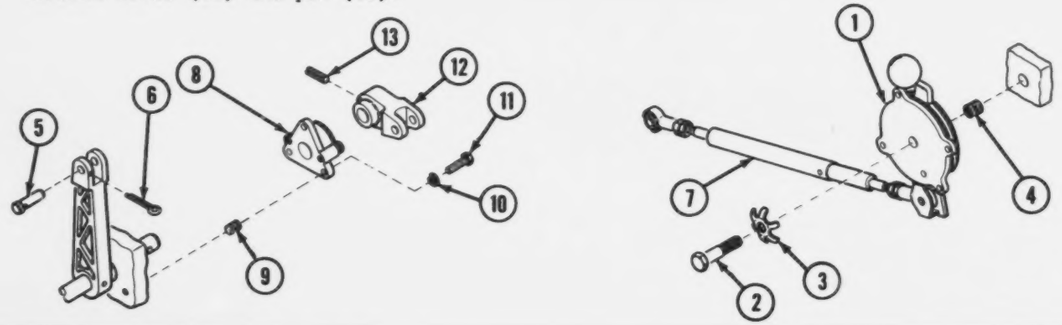
3 Install bracket support assembly (8) at bulkhead.

NOTE

Replace inserts only if threads are damaged.

4 At bracket support assembly (8), install three inserts (9), three lockwashers (10) and three screws (11).

5 Install lever (12) and pin (13).



TA472379

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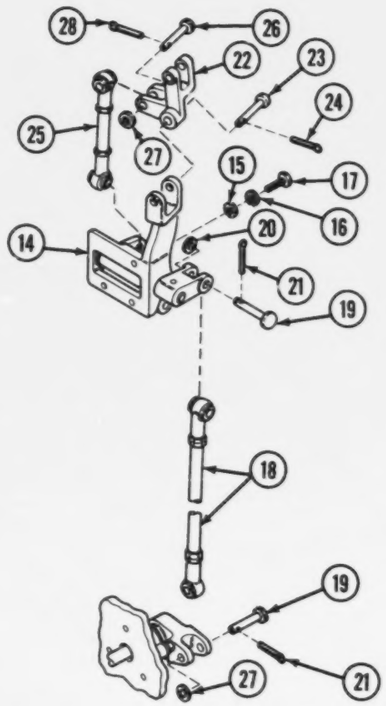


6 Install bracket assembly (14), three flatwashers (15), three lockwashers (16) and three screws (17) onto hull bulkhead.

7 Install rod assembly (18).

8 Install two pins (19), two flatwashers (20) and two cotter pins (21).

9 Install bellcrank (22).

10 Install pin (23) and cotter pin (24) at bellcrank (22).

11 Install rod assembly (25).

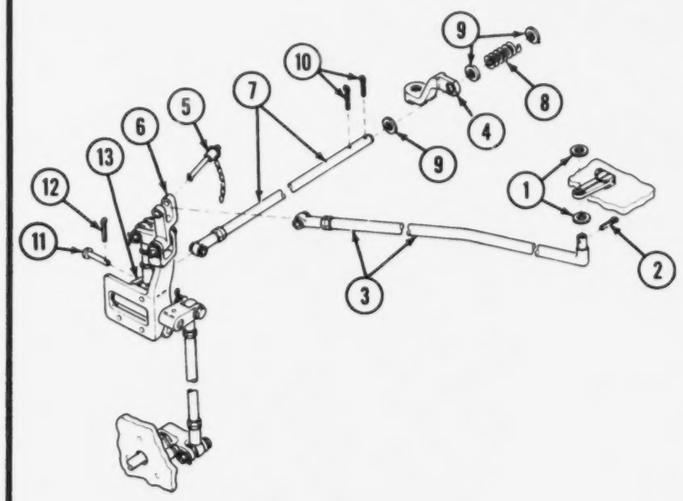
12 Install two pins (20), two flatwashers (27) and two cotter pins (28) at bellcrank (22) to install rod assembly.

TA472380

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-10. ACCELERATOR, THROTTLE AND ENGINE CONTROL GOVERNOR - CONTINUED

d. Installation - Continued



13 Install two flatwashers (1) and cotter pin (2) at end of rod assembly (3) at engine throttle control lever (4).

14 Install quick-release pin (5) at bellcrank (6).

15 Install throttle control lever (4) if damaged or requiring replacement at transmission.

16 At throttle control lever (4), install rod assembly (7), spring (8), three flatwashers (9) and two cotter pins (10).

17 For installation of linkage in powerplant, install pin (11) and cotter pin (12) at bellcrank (13).

TA472381

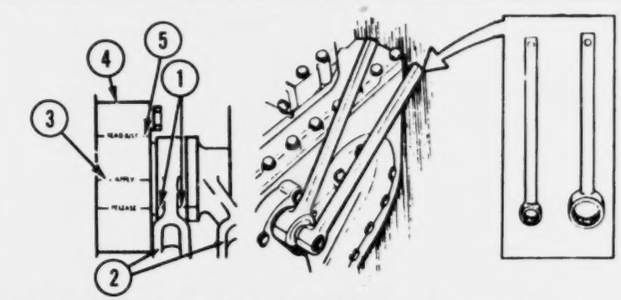
9-11. TRANSMISSION INTERNAL BRAKE

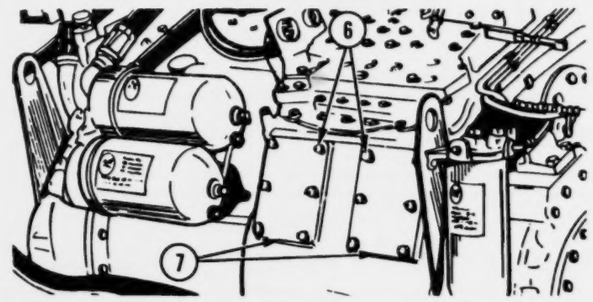
This task covers:

Adjustment

INITIAL SET-UP

Special Tools
Brake adjust wrenches (Items 39 & 40, App. B), Brake adjusting gage (Item 41, App. B)





NOTE

If the brake linkage is not installed, the brakes may be adjusted using the same procedures as outlined, except that special wrenches for brake adjustment may be used to apply the brakes. The brakes should be applied to approximately 90 lb-ft (122 Nm).

1 Check brake linkage adjustment.

2 Apply brakes fully and watch the index marks (1) on the brake levers (2). If the index marks (1) rotate to the APPLY mark (3) on the retainer (4) but not to the READJUST mark (5), the brakes are properly adjusted. If the index marks (1) do not rotate to the APPLY mark (3) or rotate past the READJUST mark (5), the brakes must be adjusted.

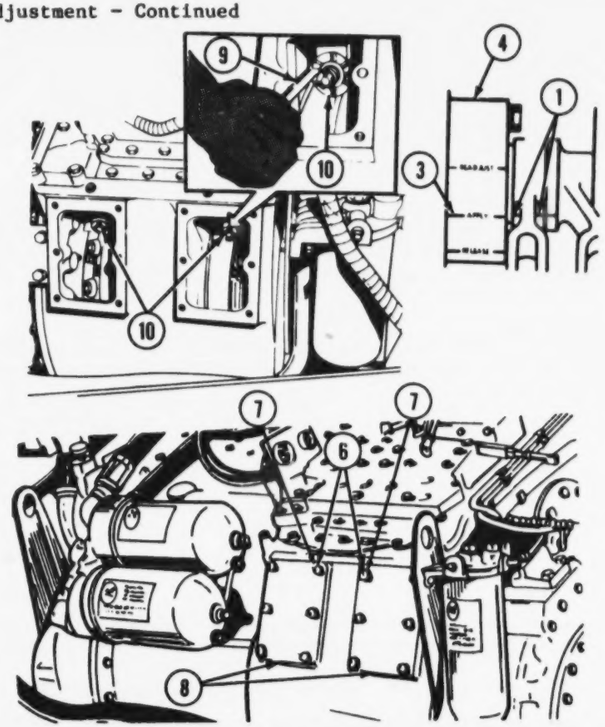
3 Remove six screws (6) and six washers (7) on each of two transmission covers (8). Remove transmission covers.

TA472382

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-11. TRANSMISSION INTERNAL BRAKE - CONTINUED

Adjustment - Continued



4 Insert screwdriver (9) into adjustment nuts (10) and turn to adjust brakes. Clockwise rotation will tighten brakes; counterclockwise will loosen brakes.

5 Adjust both brakes uniformly so that both index marks (1) align with the APPLY mark (3) on the bearing retainer (4) when brakes are applied.

6 Install covers (8) with 12 screws (6) and 12 washers (7).

NOTE

The stall test is done to check the performance of the engine, transmission, internal brake system.

7 Perform following stall test:

A. Check engine and transmission oil levels. Operate engine until normal operating temperature of approx. 170°F (77°C) is reached.

TA472383

CAUTION

Do not stall engine for more than 10 seconds or the transmission oil temperature will go too high.

B. Lock the brakes and put the transmission in fourth gear. Run the engine at full throttle for 5 seconds.

8 If brakes do not hold vehicle, readjust brakes.

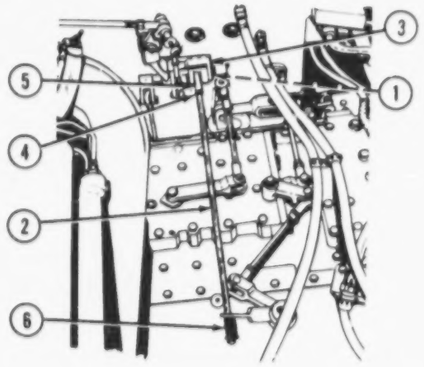
TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-12. TRANSMISSION THROTTLE VALVE

This task covers:

Adjustment

Adjustment



NOTE

Perform after engine throttle governor control rod adjustment.

1 Remove quick-release pin (1) (hidden) and remove transmission throttle valve control rod (2) from lever on throttle control lever bracket assembly (3).

2 Fully depress accelerator pedal and hold in depressed position. (Lever on throttle control lever bracket will move towards driver's bulkhead.)

3 Move transmission throttle valve lever against stop (toward driver's bulkhead).

4 Loosen nut (4) on transmission throttle valve control rod and turn rod end (5) 1/2 turn at a time, until pin (1) will freely enter rod end and lever. Insert pin and release accelerator pedal.

TA472384

5 Shorten transmission throttle valve control rod (2) to put spring (6) under compression by rotating rod end (5) clockwise two turns. This assures full travel of transmission throttle lever.

6 Tighten nut (4).

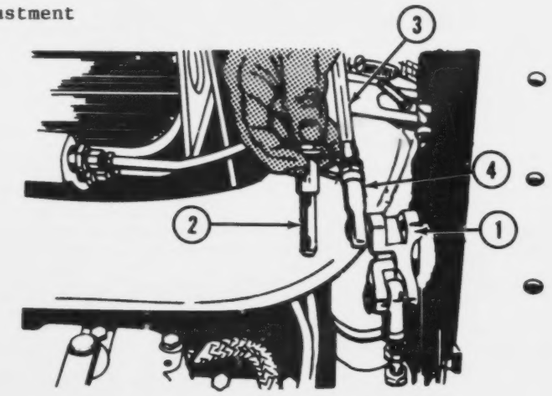
7 To adjust linkage proeprly, install transmission throttle valve control rod (2) to lever on throttle control lever bracket assembly (3). Linkage is now adjusted properly.

9-13. ENGINE THROTTLE GOVERNOR CONTROL ROD

This task covers:

Adjustment

Adjustment



1 Fully depress accelerator pedal to move engine throttle governor control rod lever (1) away from driver's bulkhead.

2 Remove quick-release pin (2), and disconnect engine throttle governor control rod (3) from lever (1).

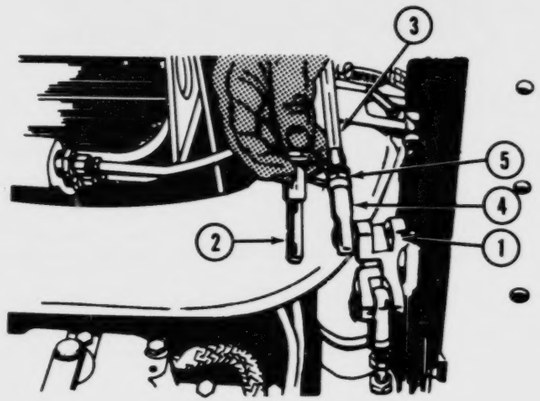
3 Push engine throttle governor control rod (3) towards rear of vehicle (accelerator still depressed) and loosen locknut (4).

TA472385

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-13. ENGINE THROTTLE GOVERNOR CONTROL ROD - CONTINUED

Adjustment - Continued



NOTE

1/4" dowel pin may be used. Fit will be tight. Pin fits through lever and into bulkhead pilot hole.

4 Note whether pin (2) removed in step 2 can be easily installed in lever (1) and control rod end (5). If it cannot, loosen nut (4) on control rod and twist rod end (4) 1/2 turn at a time until quick-release pin (2) can be installed. Tighten control rod nut (5).

5 Install rod (3) and pin (2). Linkage is now adjusted properly.

6 Release accelerator pedal.

TA472386

9-14. HAND THROTTLE GOVERNOR CONTROL ROD

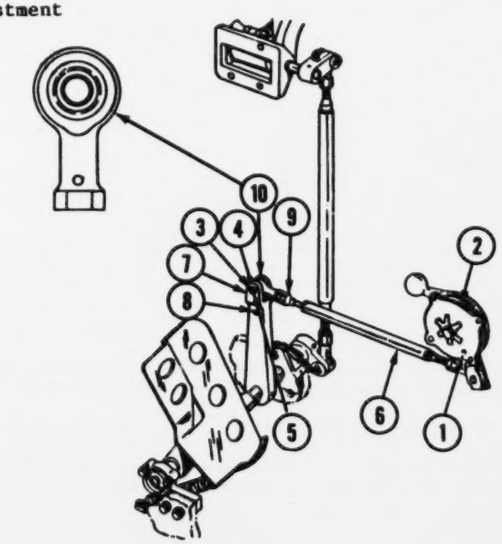
This task covers:

Adjustment

INITIAL SET-UP

Material/Parts
Cotter pin

Adjustment



NOTE

1/4" dowel may be used.

1 Insert dowel pin (0.225-inch (5.7mm diameter) in positioning hole (1) of throttle lever cover (2).

2 Remove cotter pin (3), flatwasher (4) and clevis pin (5). Discard cotter pin.

3 Remove control rod (6) from throttle lever (7).

4 Insert dowel pin (0.225-inch (5.7 mm) diameter) in positioning hole (8) in throttle lever and bulkhead.

5 Loosen locknut (9).

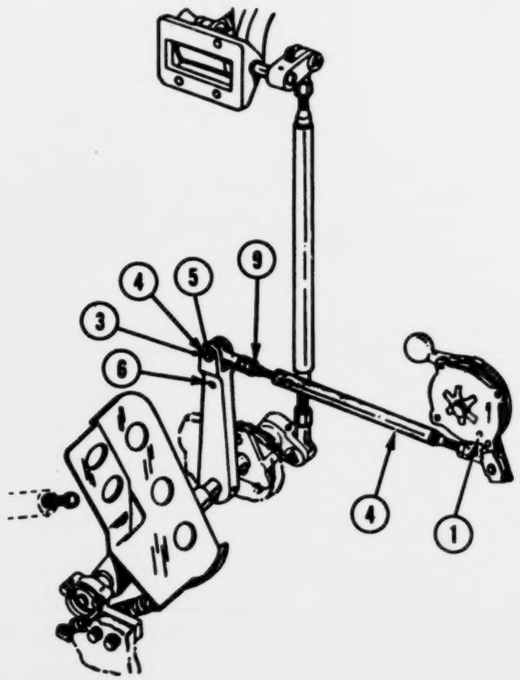
6 Adjust rod end (10) until pin (5) can be inserted easily.

TA472387

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-14. HAND THROTTLE GOVERNOR CONTROL ROD - CONTINUED

Adjustment - Continued



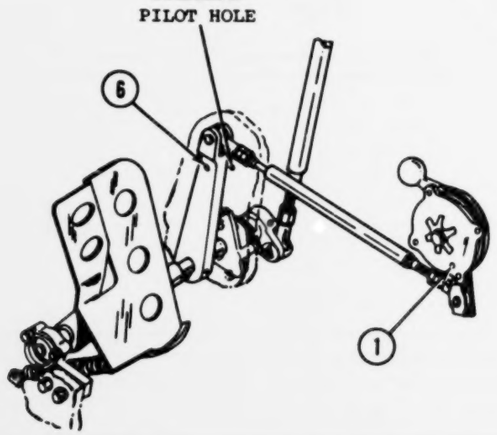
7 Tighten locknut (9).

8 Install rod (6), flatwasher (4) and clevis pin (5). Replace cotter pin (3).

9 Remove dowel pins in positioning holes (1) and (8).

10 Start engine with throttle control closed.

11 Check tachometer - engine should be at idle speed (1000-1200 rpm).



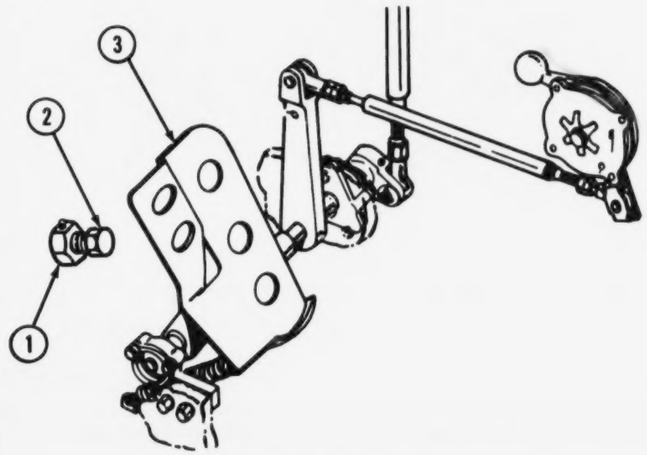
TA472388

9-15. ACCELERATOR PEDAL

This task covers:

Adjustment

Adjustment



NOTE

Insure hand throttle adjustment is correct (ref. p. 9-51).

1 Loosen jam nut (1) and then turn adjusting screw (2) completely in.

2 Depress accelerator pedal (3) until it stops. Hold pedal down in depressed position and unscrew adjusting screw (2) until it touches the accelerator pedal.

3 Tighten jam nuts (1).

TA472389

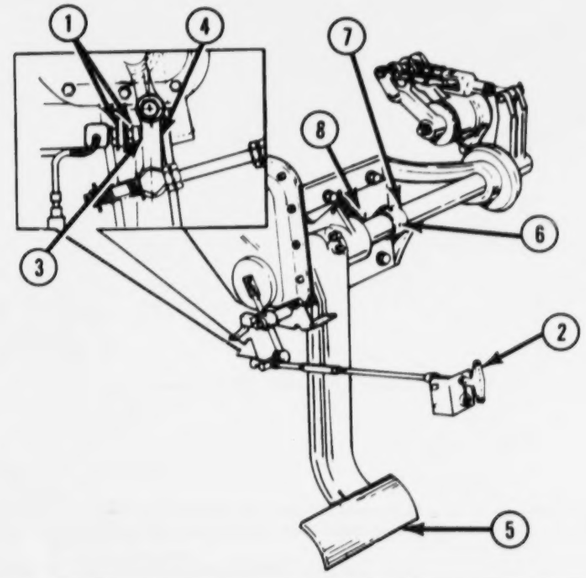
TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-16. WARNING LIGHT AND STOPLIGHT SWITCHES

This task covers:

Adjustment

Adjustment



1 To adjust warning light switch, loosen two locknuts (1) and move parking brake handle (2) out 3/8 inch (0.95 cm).

2 Adjust two locknuts (1) until switch (3) touches arm (4). Tighten two locknuts (1).

3 To adjust stoplight switch, depress brake pedal (5) 3/4 inch (19 mm) and lock brakes.

4 Loosen socket head screws (6), and turn stoplight actuator (7) until it touches stoplight switch (8).

5 Tighten screws (6).

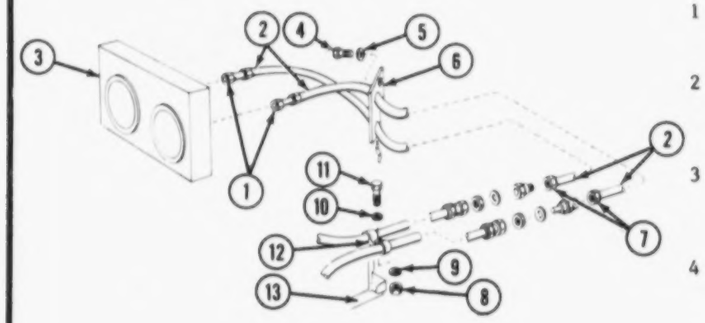
TA472390

9-17. SPEEDOMETER AND TACHOMETER SYSTEMS

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

a. Removal



1 Open transmission access door and remove front slope plate (ref. p. 4-1).

2 Remove the flexible driveshafts (2) by removing two nuts (1) from the back of the instrument panel (3).

3 Remove two screws (4), two lockwashers (5) and two clamps (6) in the driver's compartment.

4 Remove two nuts (7) and flexible drive shafts (2) from bulkhead in the driver's compartment.

5 Remove nut (8), lockwasher (9), flatwasher (10), screw (11) and retaining strap (12) at support bracket (13) on transmission.

TA472391

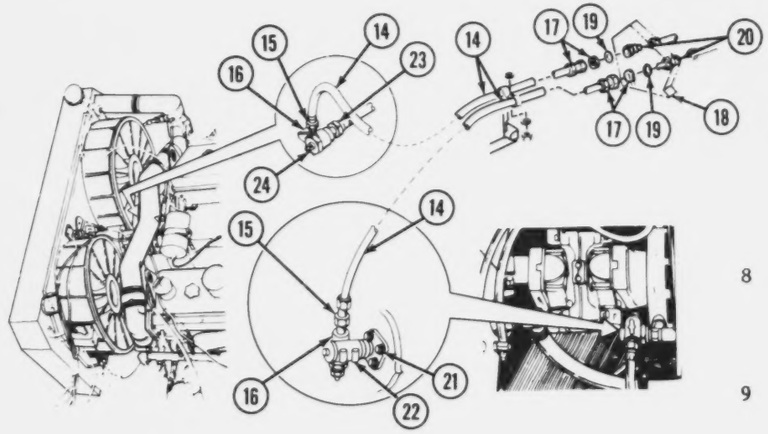
TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-17. SPEEDOMETER AND TACHOMETER SYSTEMS - CONTINUED

a. Removal - Continued

6 Remove four nuts (17), two lockwashers (19) and two couplings (20) at bulkhead (18).

7 Remove two nuts (15) and two flexible drive shafts (14) at drive joint (16).



NOTE

Speedometer adapter (22) has a keyed pin. During removal of adapter, remove and store keyed pin until ready for installation. Speedometer will not work without pin.

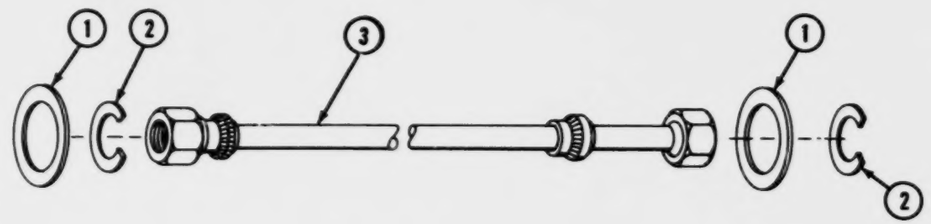
8 Remove four screws (21) and speedometer driveshaft adapter with gasket (22) from transmission at right universal joint.

9 Remove nut (23) and tachometer driveshaft adapter (24) from engine, adjacent to alternator housing.

TA472392

b. Disassembly

1 Remove two gaskets (1) and two "C" washers (2) from flexible driveshaft (3).



c. Assembly

Assemble in reverse order of disassembly.

TA472393

TRANSMISSION, TRANSFER AND DRIVE CONTROL ASSEMBLIES - SECTION II. DRIVE CONTROL ASSEMBLIES - CONTINUED

9-17. SPEEDOMETER AND TACHOMETER SYSTEMS - CONTINUED

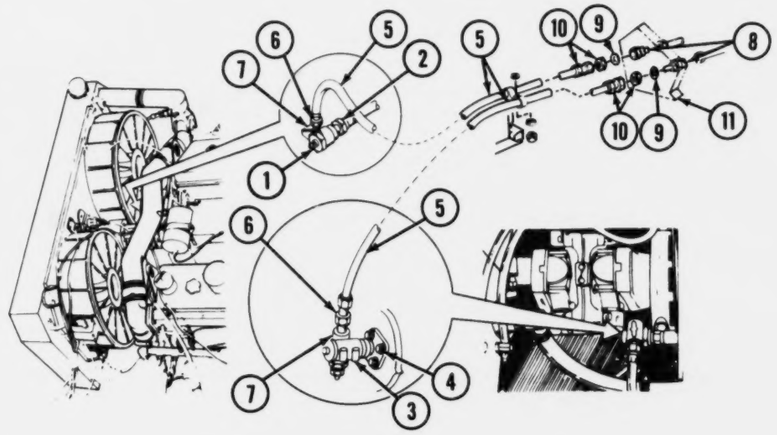
d. Installation

1 Install tachometer driveshaft adapter (1) and nut (2) into engine, adjacent to alternator housing.

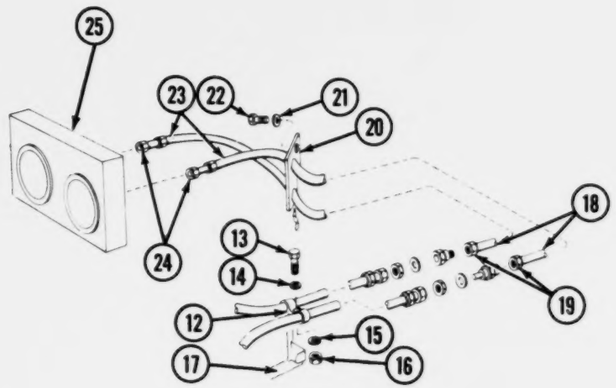
2 Install speedometer driveshaft adapter (with gasket) (3) and four screws (4). Be sure to install keyed pin (saved during removal) so that speedometer will function.

3 Install two flexible drive shafts (5) and two nuts (6) at drive joint (7).

4 Install two couplings (8), two lockwashers (9) and four nuts (10) at bulkhead (11).



TA472394



5 Install retaining strap (12), screw (13), flatwasher (14), lockwasher (15) and support bracket (17) on transmission.

6 Install flexible drive shafts (18) and two nuts (19) at bulkhead in the driver's compartment.

7 Install two clamps (20), two lockwashers (21) and two screws (22) in the driver's compartment.

8 Install the flexible driveshafts (23) by installing nuts (24) at the back of the instrument panel (25).

9 Install front slope plate and shut transmission access door to close off access door to the driver's instrument panel (25).

TA472395

CHAPTER 10
TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS

GENERAL

This chapter illustrates and defines procedures for removal, disassembly, assembly, installation, checking and adjusting the tracks, suspension system, final drive and universal joint assemblies.

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SECTION I. TRACKS

10-1 TRACK PAD 10-3
10-2 TRACK SHOE 10-4
10-3 TRACK 10-6
10-4 TRACK TENSION 10-9

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IDENTIFICATION CHART 10-11
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10-6 ROAD WHEEL HUB 10-14
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10-10 TRACK ADJUSTER AND MOUNTING BRACKET 10-25
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10-12 IDLER ARM ASSEMBLY 10-32
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SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS

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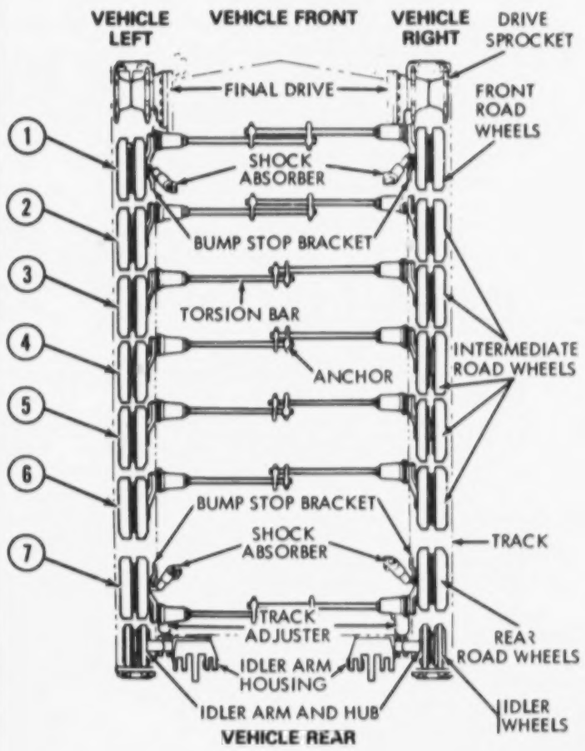
TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION I. TRACKS



Removal and installation procedures are shown for the following components:

Track pad (p. 10-3)
Track shoe (p. 10-4)
Road wheels (p. 10-12)
Road wheel arms (p. 10-18)
Torsion bars (p. 10-20)
Torsion bar anchors (p. 10-22)
Track adjuster and mounting bracket (p. 10-25)
Idler wheels and hub (p. 10-28)
Idler arm assembly (p. 10-32)
Idler arm housing (p. 10-35)
Shock absorber and mount (p. 10-36)
Shock absorber bearing (p. 10-38)
Final drive sprocket and hub (p. 10-40)
Final drive assembly (p. 10-42)
Universal joints (p. 10-45)

Disassembly and assembly procedures are given for road wheel hubs (p. 10-14) and idler arm assembly (p. 10-32).

This chapter also illustrates and describes disconnecting a track (p. 10-4), installation of a thrown track (p. 10-6), and track replacement (p. 10-5).

Checking and adjusting of track tension are described on page 10-9.

Refer to support maintenance for disassembly and assembly of the road wheel arm upper spindle and housing group.

Vehicle suspension system is illustrated. Numbers 1 through 7 refer to the road wheel removal procedures on page 10-12. TA472396

10-1. TRACK PAD

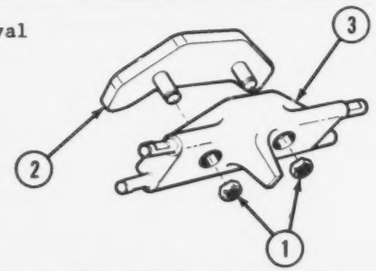
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Track pad

a. Removal



1 Remove two pad nuts (1).

2 Lift or pry pad (2) from track shoe (3) and discard track pad (2).

b. Installation

1 Install in reverse order of removal.

2 Clean track shoe (3).

3 Replace track pad (2).

4 Torque nuts (1) to 50 to 55 lb-ft (68 to 74 Nm).

TA472397

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION I. TRACKS - CONTINUED

10-2. TRACK SHOE

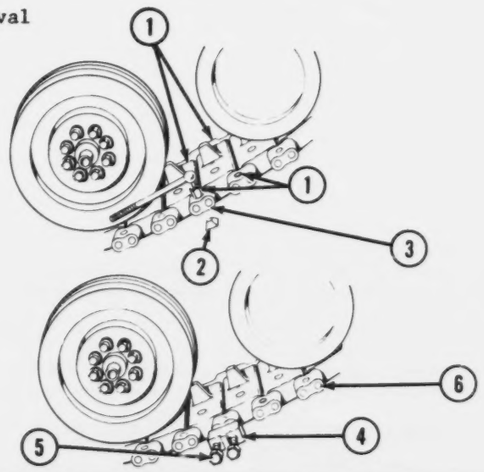
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Special Tools
Track connecting fixtures (2) (Item 9, App. B)

a. Removal



NOTE

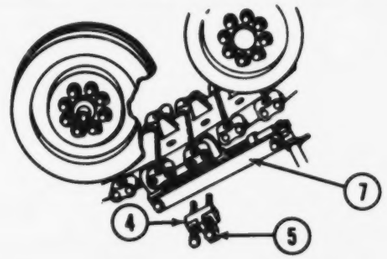
Move vehicle so that track shoe to be removed is off the ground, either between the road wheel and the idler wheel or between the drive sprocket and the front road wheels.

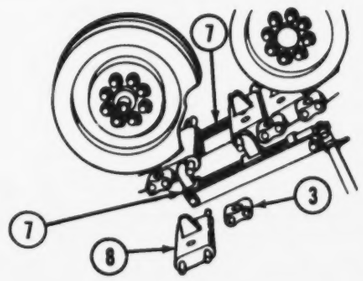
1 Decrease track tension (ref. p. 10-9).

2 Remove four bolts (1) and four retaining wedges (2) from four end connectors (3) from track shoe to be removed.

3 Install end connector puller (4). Tighten screws (5) against ends of track link pins (6).

TA472398





4 Tighten two screws (5) until each of the four end connectors moves out approximately 1 inch (2.54 cm).

NOTE

Tighten both fixtures equally removing tension from shoe or track connectors being removed.

5 Install track-connecting fixtures (7) on both ends of shoe being removed, engaging track link pins (6) on adjacent shoes. Hold ends of track until shoe is replaced.

6 Remove four end connectors (3), end connector puller (4) with screws (5) and track shoe (8).

b. Installation

WARNING

Track is heavy. Before removing track-connecting fixtures, support weight of track with crow bar to lower track to ground, to prevent possible injury.

1 Reverse order of removal of track shoe and connectors. Puller (4) is not used to reassemble end connector.

2 Torque bolt and retaining wedge to 90 to 100 lb-ft (122 to 135 Nm).

TA472399

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION I. TRACKS - CONTINUED

10-3. TRACK

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Special Tools
Track connecting fixtures (2) (Item 9, App. B)

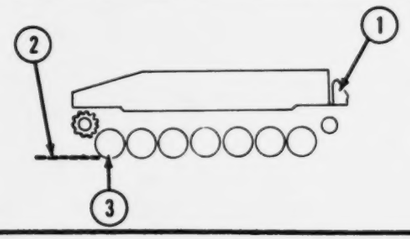
Personnel Required
3

a. Removal

1 Perform steps 1 through 6 of paragraph 10-2. Remove only two end connectors when removing the whole track.

2 Pull straight forward slowly allowing the track to unravel from the roadwheels.

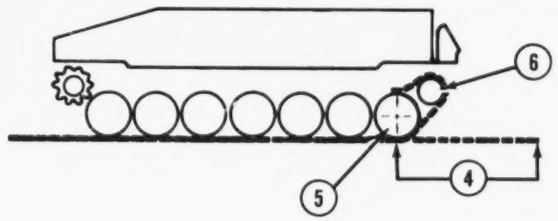
b. Installation

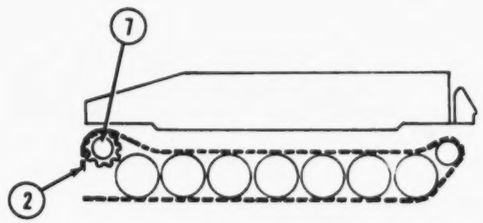


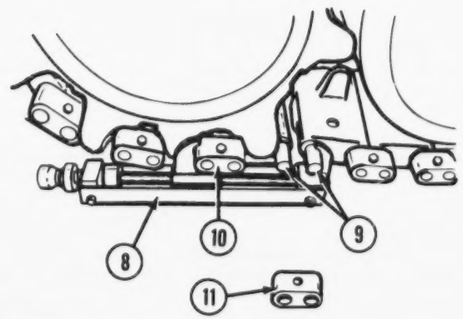
1 Raise rear fender to upper position.

2 Lay track (2) out in front of vehicle in a straight line directly ahead and touching the first road wheel (3).

TA472400







CAUTION

Use extreme care when moving vehicle on only one track. Drive slowly, moving only short distances.

3 Drive slowly onto track until 11 track shoes (4) extend past centerline of last road wheel (5).

4 Lift track with tanker bar over idler wheel (6) to top of last road wheel (5).

CAUTION

Raise end of track with crow bar to prevent it from getting caught between road wheels.

5 Drive forward slowly, shifting lever F-1.

6 Steer in direction of removed track (2).

7 Stop when track can be laid on drive sprocket (7).

8 Steer towards opposite track.

9 Move forward slowly.

10 Stop vehicle when track-connecting fixture (8) can be connected to track end link pins (9) on both ends of track (2).

11 Apply parking brakes.

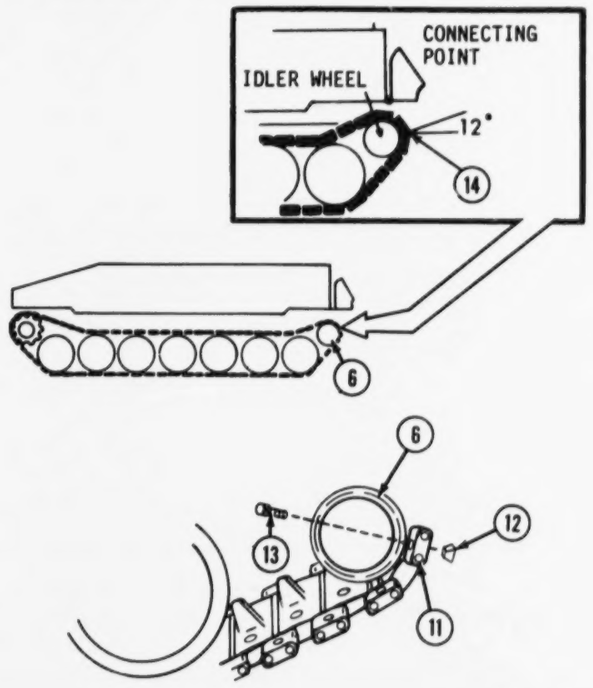
12 Install two track connecting fixtures (8) over track end link pins (9).

TA472401

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION I. TRACKS - CONTINUED

10-3. TRACK - CONTINUED

b. Installation - Continued



13 Tighten two track-connecting fixtures (8) until track end link pins (9) are close enough for fixture to be installed on nearest end connector (10).

14 Reinstall fixture on nearest end connector (10) and track end link pins (9).

15 Tighten until end connectors can be installed on track end link pins.

16 Install two end connectors (11) and tap lightly with hammer to secure them.

17 Remove two track connecting fixtures (8).

18 Drive forward until two end connectors (11) are on idler wheel (6) at point (14). (Point (14) on idler wheel (6) positions adjacent track shoes at approximately a 12^{o} angle between inner faces of track shoes.

CAUTION

Do not tighten the wedge bolts when the track shoes form a straight line.

19 Install two bolts (13) and two wedges (12) in end connectors (11). Torque bolt (13) to approximately 90 to 100 lb-ft (122 to 135 Nm). Torque bolts again after 50 miles (80 Km) of operation.

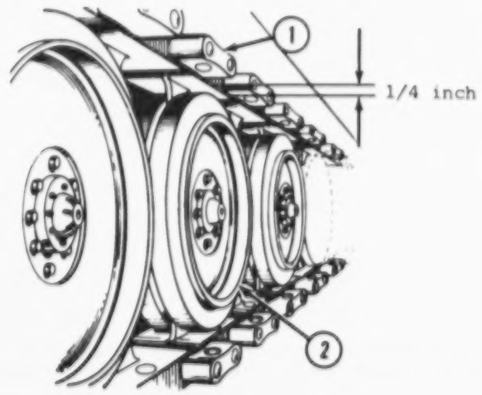
TA472402

10-4. TRACK TENSION

This task covers:

a. Checking b. Adjusting

a. Checking



1 To exercise tracks, drive vehicle forward and reverse several times.

2 Coast to a stop without using brakes.

3 Place transmission in neutral position.

4 Shut off engine.

5 Measure distance from bottom of track (1) to top of third roadwheel (2). Distance should be 1/4 inch (6.4 mm).

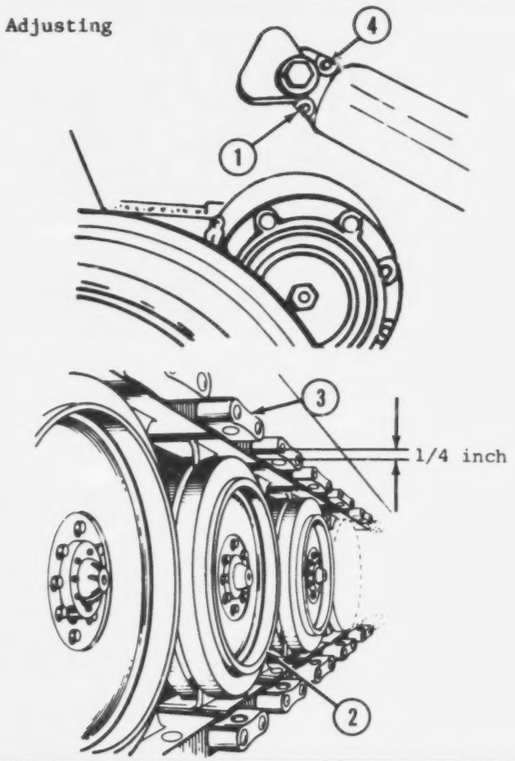
6 Adjust track tension if required.

TA472403

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION I. TRACKS - CONTINUED

10-4. TRACK TENSION - CONTINUED

b. Adjusting



CAUTION

Do not allow track adjuster to extend more than 3-1/2 inches (8.9 cm). Remove a shoe to shorten track if necessary.

1 Clean input pressure fitting (1).

2 Add lubricant until distance from top of roadwheel (2) to bottom of track (3) is 1/4 inch (6.4 mm).

3 To increase tension, raise track away from third roadwheel (2).

4 To decrease track tension, slowly loosen bleed plug (4).

5 Allow lubricant to escape until track hangs loose.

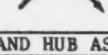
6 Clean off excess lubricant.

7 Tighten bleed plug (4).

8 Adjust track to desired tension. (Increase track tension to achieve 1/4 inch (6.4 mm) measurement between road wheel and track).

TA472404

TORSION BAR, ANCHOR AND ROAD WHEEL ARM AND HUB ASSEMBLY IDENTIFICATION CHART (LEFT)

VEHICLE POSITION	TORSION BAR PART NUMBER	IDENTIFYING ARROW (PRESET)	ANCHOR PART NO.	LOCATION OF BLIND SPLINE IN ANCHOR	ROAD WHEEL ARM AND HUB ASSEMBLY PART NO.
1 FRONT	10898191-1		10921192-1	12 O'CLOCK	10925061-1
2 INTERMEDIATE	10898191-1		10921192-1	12 O'CLOCK	10925059
3 INTERMEDIATE	10898193		10921192-1	12 O'CLOCK	10925059
4 INTERMEDIATE	10898193		10921192-1	12 O'CLOCK	10925059
5 INTERMEDIATE	10898193		10921192-1	12 O'CLOCK	10925059
6 INTERMEDIATE	10898193-1		10921192-1	12 O'CLOCK	10925059
7 REAR	10898191-2		10921192-2	12 O'CLOCK	10925061-2

TORSION BAR, ANCHOR AND ROAD WHEEL ARM AND HUB ASSEMBLY IDENTIFICATION CHART (RIGHT)

VEHICLE POSITION	TORSION BAR PART NUMBER	IDENTIFYING ARROW (PRESET)	ANCHOR PART NO.	LOCATION OF BLIND SPLINE IN ANCHOR	ROAD WHEEL ARM AND HUB ASSEMBLY PART NO.
1 FRONT	10898191-2		10921192-2	12 O'CLOCK	10925061-2
2 INTERMEDIATE	10898191-2		10921192-2	12 O'CLOCK	10925059
3 INTERMEDIATE	10898194		10921192-2	12 O'CLOCK	10925059
4 INTERMEDIATE	10898194		10921192-2	12 O'CLOCK	10925059
5 INTERMEDIATE	10898194-1		10921192-2	12 O'CLOCK	10925059
6 INTERMEDIATE	10898194-1		10921192-2	12 O'CLOCK	10925059
7 REAR	10898191-1		10921192-1	12 O'CLOCK	10925059-1 *10925061-1

* This # applies to M109A2 only.

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION I. TRACKS - CONTINUED

10-5. ROAD WHEELS

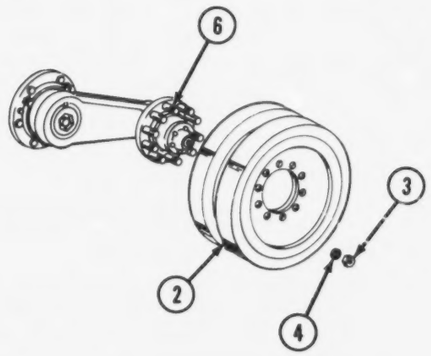
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Special Tools	Personnel Required
5-ton jack	2
Track connecting fixture (Item 9, App. B)	
Lifter (Item 13, App. B)	

a. Removal



NOTE

This removal procedure to be followed for roadwheels 2 through 6 only.

1 Disconnect track (1) (ref. p. 10-4).

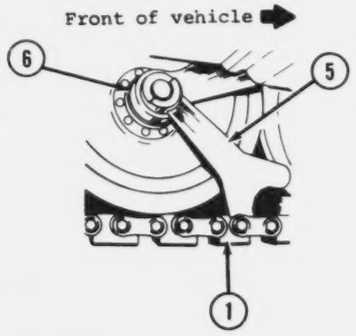
2 Pull track away from top of roadwheel (2).

3 Loosen but do not remove ten nuts (3) and ten washers (4).

4 Place lifter (5) on roadwheel arm hub (6) and on inner side of track (1).

TA472405

VIEW FROM UNDER VEHICLE



WARNING

When driving vehicle on or off lifters, clear the area. Lifters may fly out from under the vehicle and cause serious injury to personnel.

5 Drive forward slowly, only far enough to lift roadwheel off track.

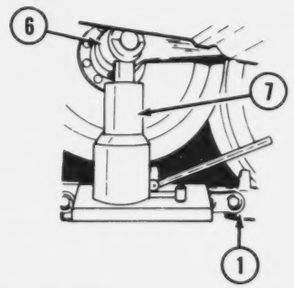
6 Remove ten nuts (3) with ten washers (4).

7 Remove road wheel (2), tapping lightly with hammer.

NOTE

This removal procedure to be used for road wheels 1 and 7 only.

8 Disconnect track (1)and pull track away from top of road wheel (2).



WARNING

Use extreme caution when using hydraulic jack. Carelessness can result in damage to equipment or injury to personnel.

9 Loosen but do not remove ten nuts (3) with ten washers (4).

10 Position jack base (7) on track and locate head of jack under spindle extension of road wheel arm.

11 Move jack up until road wheel clears track.

12 Remove ten nuts (3) with ten washers (4) and remove road wheel.

b. Installation

1 Install in reverse order of removal.

2 Torque ten nuts to 170 to 180 lb-ft (230 to 243 Nm).

TA472406

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-6. ROAD WHEEL HUB

This task covers:

a. Disassembly b. Assembly

INITIAL SET-UP

Material/Parts
GAA grease or lubricating oil (Item 26 or 33, App. C)
Cotter pin
Packing
Inner hub oil seal

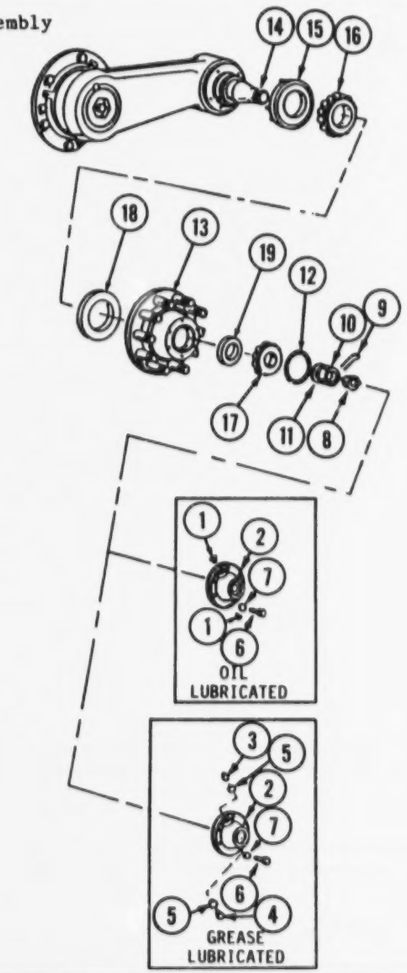
Personnel Required
2

Special Tools
Outer bearing cup remover/replacer/handle (Items 18 and 20, App. B)
Inner bearing cup remover/replacer/handle (Items 17 and 20, App. B)
Replacer, inner oil seal (Item 21, App. B)

NOTE

For additional information and initial oil to grease conversion of the road wheel hubs refer to TB 43-0001-39-4, 1 JAN 85.

a. Disassembly



1 Remove road wheels (ref. p. 10-12).

NOTE

Follow step 2 for oil-lubricated hub only.

2 Remove two plugs (1) from cap (2). Drain oil from cap.

NOTE

Follow step 3 for grease-lubricated hub only.

3 Remove grease fitting (3), relief valve (4) and two bushings (5) from cap (2).

4 Remove six capscrews (6) and six lockwashers (7). Remove cap (2).

5 Remove static spring (8), cotter pin (9), nut (10), flatwasher (11) and packing (12).

6 Using both hands, carefully slide road wheel hub (13) from the road wheel arm spindle (14).

7 Remove and discard inner hub oil seal (15).

8 Remove bearing cones (16) and (17) from hub.

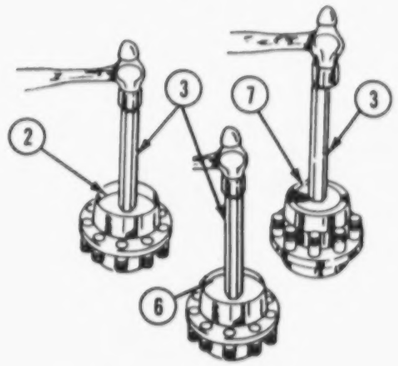
9 If damaged, remove bearing cups (18) and (19) from hub, using remover and handle.

TA472407

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-6. ROAD WHEEL HUB - CONTINUED

b. Assembly



1 Install inner bearing cup (1) using inner bearing cup replacer (2) and handle (3).

NOTE

Follow step 2 for grease-lubricated hub only.

2 Pack inner bearing cone (4) with GAA grease.

3 Install inner bearing cone (4).

4 Around inner hub bore, apply a bead of sealer (Item 47, App. C) 1/64 to 1/32 inch wide. Install inner hub oil seal (5) using seal replacer (6) and handle (3).

5 Using outer bearing cup replacer (7) and handle (3), install outer bearing cup (8).

6 Install outer bearing cone (9).

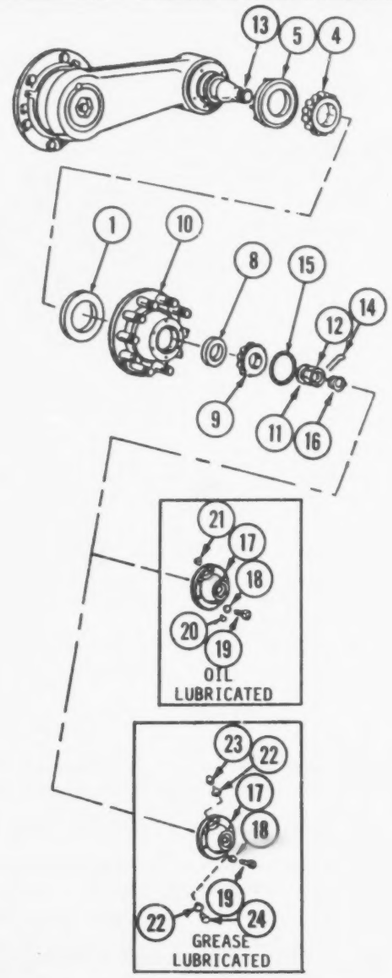
7 Assemble hub (10), washer (11) and nut (12) on spindle (13).

8 Torque nut (12) as follows:

A. Using torque wrench, tighten nut to 100 lb-ft (135 Nm).

B. Back off nut one complete turn.

TA472408



C. Using torque wrench, tighten nut to 30 lb-ft (40.5 Nm) while rotating hub.

D. If slots in nut and hole in spindle (13) line up, install cotter pin (14).

E. If misaligned, back off nut to line up with first hole in spindle, and then install cotter pin (14).

F. After adjustment, hub (10) must rotate freely by hand.

NOTE

Follow steps 9 and 10 for oil-lubricated hubs only.

9 Install packing (15), static spring (16) and cap (17). Install six lockwashers (18) and six capscrews (19). Tighten six capscrews to 12 lb-ft (16 Nm).

10 Install bottom plug (20). Fill cap (17) with oil using direct delivery fluid gun, to half-way level on sight gage and install top plug (21) (ref. TM 9-2350-311-10).

NOTE

Follow steps 11 and 12 for grease-lubricated hubs only.

11 Install packing (15), static spring (16) and GAA grease-filled cap (17). Install six lockwashers (18) and six capscrews (19). Tighten screws to 12 lb-ft (16 Nm).

12 Install two bushings (22), grease fitting (23) and relief valve (24). Fill hub with GAA grease until air-free grease flows from relief valve.

TA472409

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-7. ROAD WHEEL ARM

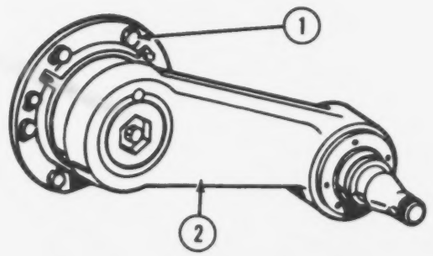
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Personnel Required
2

a. Removal



1 Disconnect track (ref. p. 10-6).

2 Remove road wheel (ref. p. 10-12).

NOTE

Follow step 3 for road wheel arms 1 or 7 only.

3 Disconnect shock absorber (ref. p. 10-36).

4 Remove torsion bar (ref p. 10-19).

5 Remove eight screws (1).

TA472410

WARNING

Roadwheel arm assembly is heavy (over 100 lb (45.5 Kg)). Use two personnel to remove.

6 Lift off road wheel arm assembly (2) to remove.

b. Installation

1 Install in reverse order of removal.

2 Torque eight screws (1) on road wheel arm assembly to 170 to 180 lb-ft (230-243 Nm).

10-8. TORSION BAR

This task covers:

a. Removal b. Installation

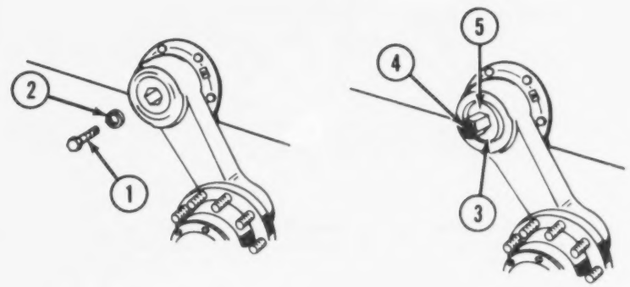
INITIAL SET-UP

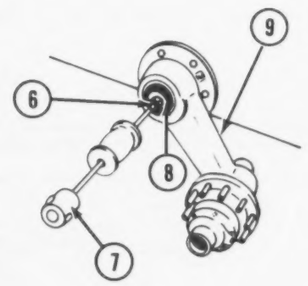
Special Tools	Personnel Required
Wrench, torsion bar (Item 19, App. B)	2
Adapter (Item 8, App. B)	
Slide hammer puller (Item 14, App. B)	

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-8. TORSION BAR - CONTINUED

a. Removal - Continued





NOTE

When removing the torsion bar at number 1 (front) or number 7 (rear) road wheel position, it will be necessary to disconnect the shock absorber (ref. p. 10-36). Remove lockwire and loosen anchor screws one full turn before attempting to remove or install torsion bars.

1 Remove screw (1) and lockwasher (2) from torsion bar plug (3).

2 Insert wrench (4) in torsion bar plug (3). Turn counterclockwise and remove plug and gasket (5).

3 Install adapter (6) and puller (7), and remove torsion bar (8). Lift road wheel arm (9) enough to take weight off the torsion bar.

TA472411

b. Installation

1 Refer to the portion of the identification chart at the beginning of this section that is applicable to the torsion bar you are replacing.

2 Lubricate splines at each end of torsion bar (8) with GAA grease (Item 26, App. C).

CAUTION

- Do not remove protective tape from ground (unsplined) surface of torsion bars.
- Do not use any tool other than torsion bar slide hammer puller.
- Torsion bar should slide in by hand. If not, use slide hammer puller as necessary.

3 Clean and dry torsion bar anchor cavities (ref. p. 10-22).

NOTE

Hold road wheel arms 1 through 6 at 4 o'clock position on vehicle left side and 8 o'clock on right, hold number 7 roadwheel arm at 8 o'clock on vehicle left side and 4 o'clock on right side while installing torsion bars.

4 Insert torsion bar (8), making certain splines on each end of torsion bar are aligned with blind splines in anchor and road wheel arm.

5 Torque anchor screws (ref. p. 10-22) and install lockwire.

6 Install gasket (5) and torsion bar plug (3).

7 Install lockwasher (2) and screw (1). Torque screw to 90 lb-ft (122 Nm).

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-9. TORSION BAR ANCHOR

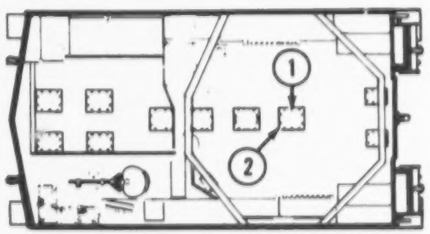
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Lockwire (as required)
Oil, PD1, PD2, or grease sealer (Item 49, App. C)

a. Removal

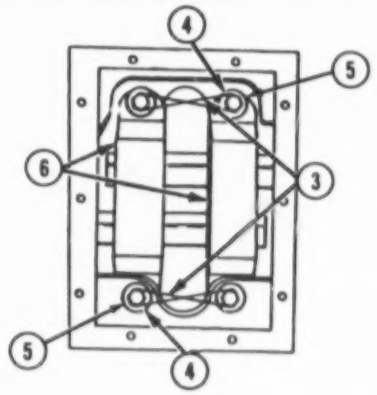


NOTE

- If torsion bar anchors for road wheels 1, 2, or 3 must be removed, remove powerplant to gain access to cover plates (ref. p. 4-1).
- There are five additional torsion bar anchor cover plates in crew compartment.

1 Remove each torsion bar anchor cover plate (1) by removing ten screws (2).

TA472412



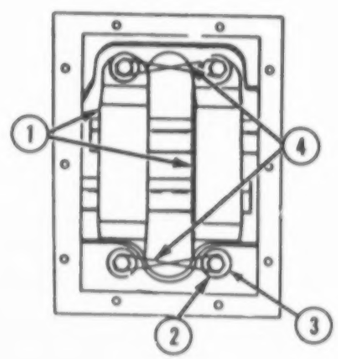
2 Remove lockwire (3) and discard. Loosen two anchor bar screws (4) and four flatwashers (5).

3 Remove torsion bars (ref. p. 10-20).

4 Remove two anchor bar screws (4) and four flatwashers (5).

5 Remove 14 torsion bar anchors (6).

b. Installation



1 Remove any water accumulation or dirt in cavities and dry thoroughly.

2 Install torsion bar anchors (1).

3 Install torsion bars (ref. p. 10-20).

4 Install four flatwashers (2) and two screws (3). Torque to 230 to 260 lb-ft (311 to 351 Nm). Replace lockwire (4).

5 Cover accessible surfaces of torsion bars and anchors with film of preservative engine oil, PE 1 or PE 2, or grease.

TA472413

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

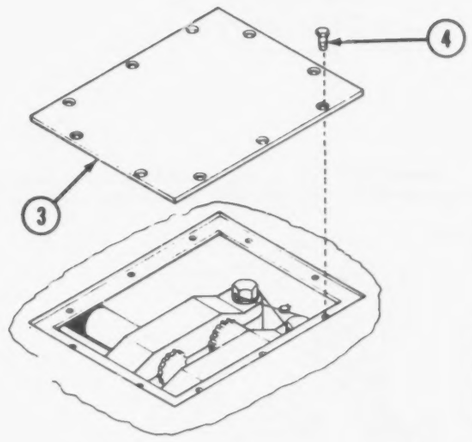
10-9. TORSION BAR ANCHOR - CONTINUED

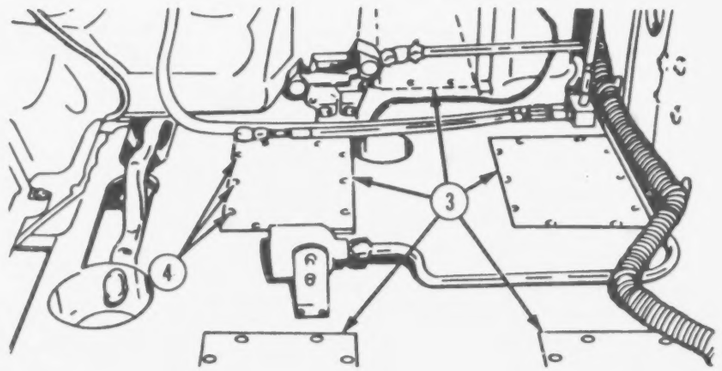
b. Installation - Continued

6 Place a band of sealer (Item 49, App. C) 1/16 inch (1.58-mm) wide around edges of each cover plate (3) (including screw holes).

7 Coat cover plate screw threads with sealer (Item 49, App. C) and install cover plates (3) with ten screws. Tighten screws (4) to 15 to 20 lb-ft (20 to 27 Nm).

8 Remove any excess sealer from around edges of covers.





TA472414

10-10. TRACK ADJUSTER AND MOUNTING BRACKET

This task covers:

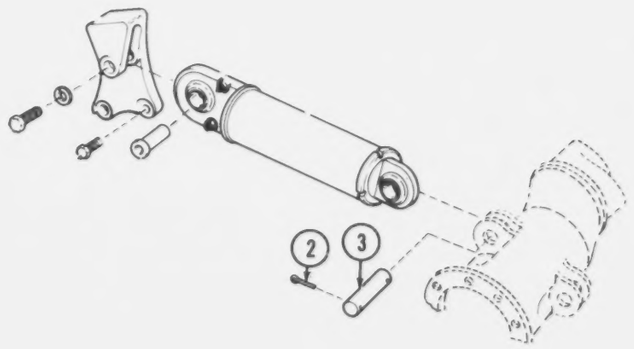
a. Removal b. Installation

INITIAL SET-UP

Special Tools
Slide hammer puller (Item 14, App. B)

Materials/Parts
Lubricant
Cotter pin (2)
Preformed packing (2)

a. Removal



WARNING

Lubricant is under high pressure. Loosen bleed plug slowly to avoid injury or severe burns.

NOTE

It is not necessary to disconnect track or remove idler wheels in order to remove or install track adjuster. Wheels are shown removed for clarity.

1 Loosen bleed plug (1) to reduce track tension.

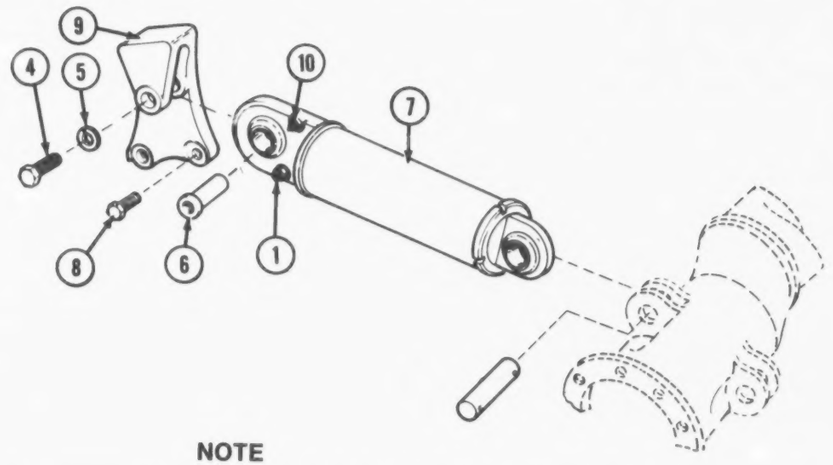
2 Remove two cotter pins (2) and two pins (3). Discard both cotter pins.

TA472415

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-10. TRACK ADJUSTER AND MOUNTING BRACKET - CONTINUED

a. Removal - Continued



NOTE

Fabricate an adapter to pull pivot pin by welding a 1-inch NC thread nut to the head of a 7/8-inch NF thread bolt, 2 inches (5 cm) long. Use with puller when required.

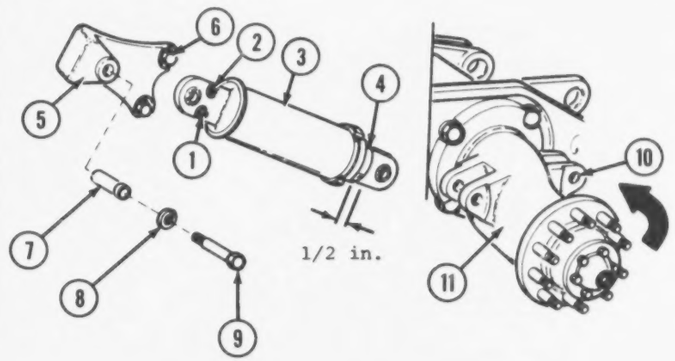
3 Remove screw (4) and lockwasher (5), pivot pin (6), and adjuster (7).

4 Remove two screws (8) and mounting bracket (9).

5 Remove bleed plug (1) and input pressure fitting (10).

TA472416

b. Installation



1 Install bleed plug (1) and input pressure fitting (2).

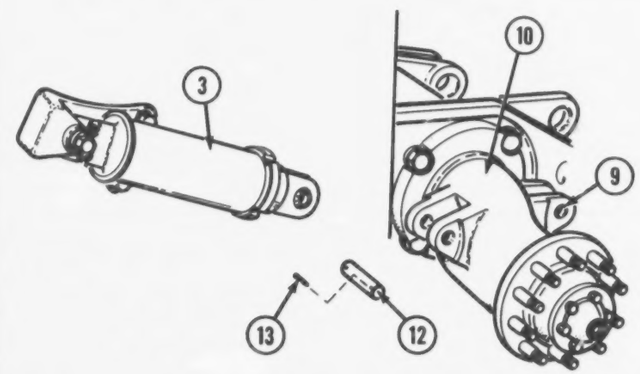
2 Add lubricant to adjuster (3) through input pressure fitting (2) until piston (4) is extended 1/2 to 1 inch (12.7 to 25.4 mm).

3 Install mounting bracket (5) and two screws (6). Torque screws to 300-350 16 lb-ft (406.7 to 474.6 Nm).

4 Install adjuster (3), pivot pin (7), and washer (8) and screw (9). Torque screw to 300-350 lb-ft (406.7 to 474.6 Nm).

5 Install pin in lug hole (10) of idler arm assembly (11).

6 Rotate assembly counterclockwise with pry bar.



7 Install adjuster (3) and pin (12) and replace two cotter pins (13). Adjust track (ref. p. 10-10).

TA472417

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-11. IDLER WHEELS AND HUB

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Cotter pins (3)
GAA grease (Item 24, App. C) or lubricating oil (Item 32, App. C)

a. Removal

NOTE

For additional information and initial oil to grease conversion of the idler wheels and hub refer to TB 43-0001-39-4.

1 Remove track (ref. p. 10-6).

2 Remove ten nuts (1).

3 Remove outer idler wheel (2), spacer (3) and inner idler wheel (4).

NOTE

Follow step 4 for oil-lubricated wheel and hub only.

4 Remove two plugs (5) from cap (6). Drain oil.

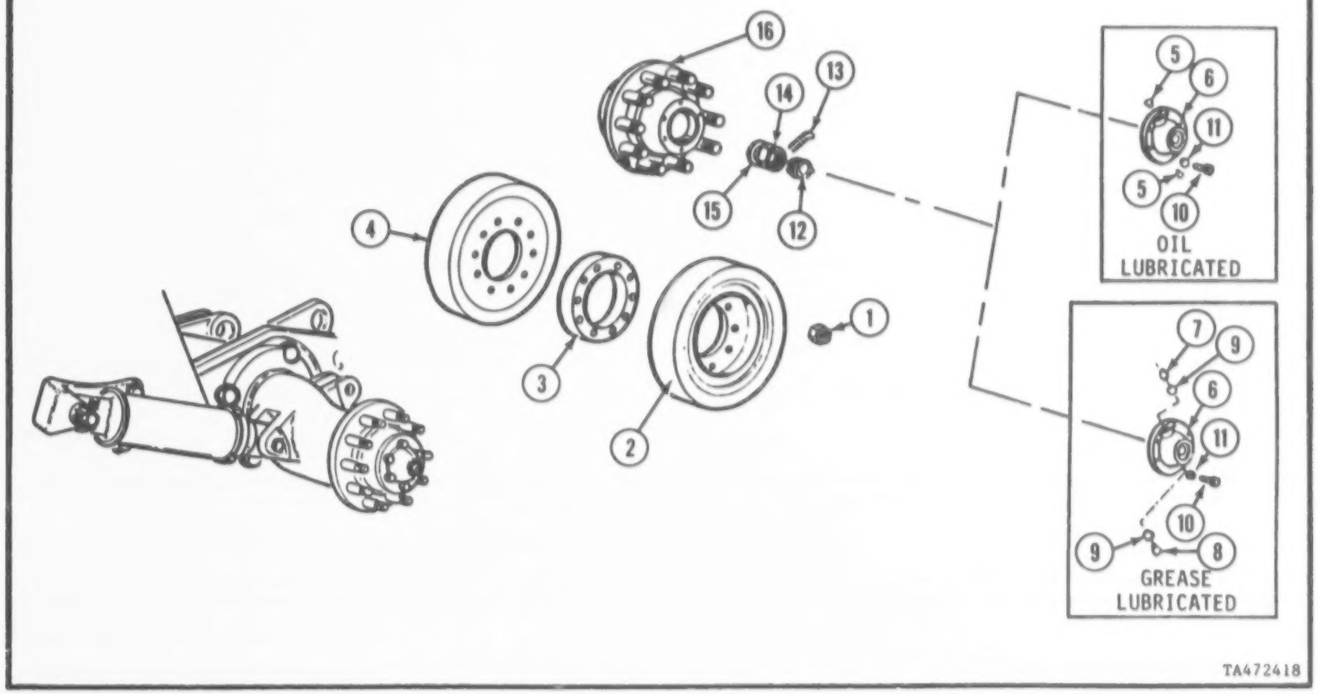
NOTE

Follow step 5 for grease-lubricated idler wheels and hub only.

5 Remove grease fitting (7), relief valve (8), and two bushings (9) from cap (6).

6 Remove six screws (10), six lockwashers (11) and cap (6).

7 Remove static spring (12), cotter pin (13), nut (14), washer (15) and hub assembly (16). Discard cotter pin.



TA472418

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-11. IDLER WHEELS AND HUB - CONTINUED

b. Installation

I Install washer (1), nut (2), new cotter pin (3) and static spring (4) in hub assembly (5).

NOTE

Follow steps 2 and 3 for grease-lubricated idler wheels and hub only.

2 Install two bushings (6), relief valve (7) and grease fitting (8) in cap (9).

3 Pack cap (9) with GAA grease (Item 26, App. C) before installation on hub assembly (5).

4 Install cap (9), six lockwashers (10) and six screws (11). Torque six screws to 12 lb-ft (15 Nm).

5 Install inner idler wheel (12), spacer (13) and outer idler wheel (14).

6 Install ten nuts (15). Torque ten nuts to 180 lb-ft (243 Nm).

NOTE

Follow steps 7, 8 and 9 for oil-lubricated idler wheels and hub only.

7 Install bottom plug (16) in cap (9).

8 Refill cap (9) with oil (Item 32, App. C).

9 Install top plug (17).

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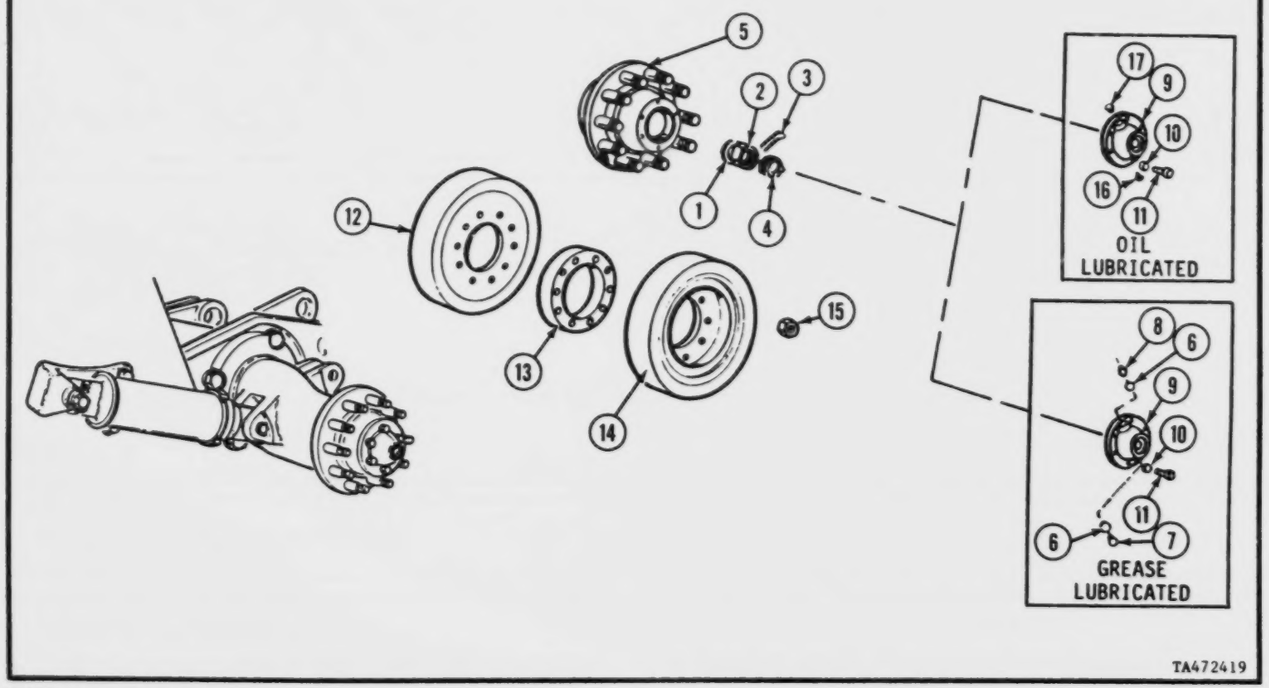
NOTE

Follow step 10 for grease-lubricated idler wheels and hub only.

10 Fill hub assembly (5) with GAA grease (Item 26, App. C) until air-free fluid flows from relief valve (7).

11 Install track (ref. p. 10-6).



TA472419

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-12. IDLER ARM ASSEMBLY

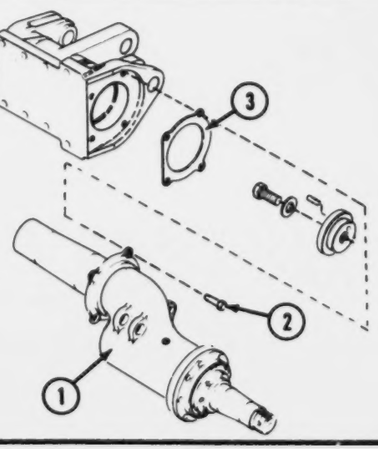
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Material/Parts
Preformed packing (2)
GAA grease (Item 26, App. C)
Seal, Gasket, Plug

a. Removal



1 Remove track (ref. p. 10-6).

2 Remove idler wheels and hub (ref. p. 10-28).

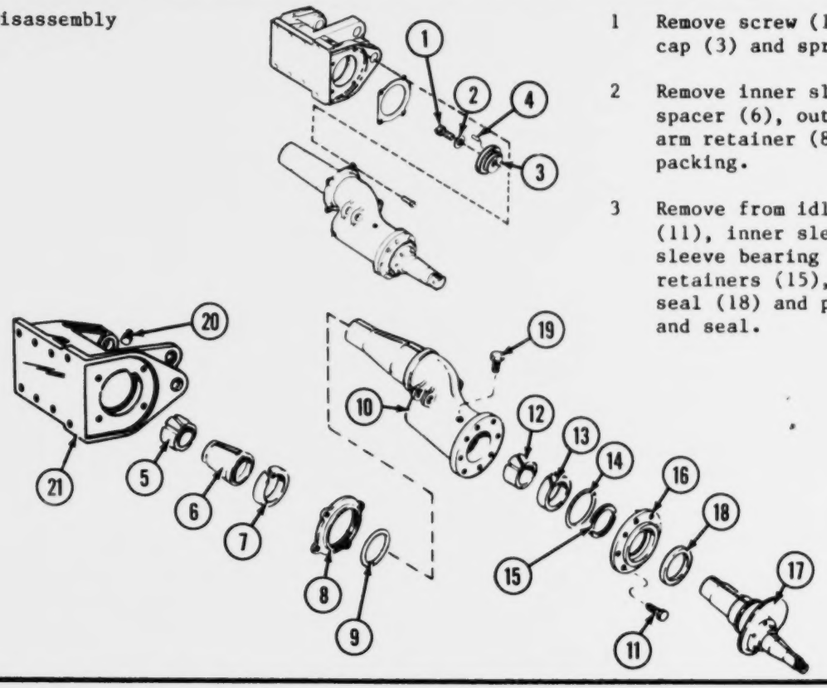
3 Disconnect track adjuster at idler arm assembly (1) (ref. p. 10-25).

4 Remove four screws (2).

5 Remove idler arm assembly (1) and gasket (3) from idler arm housing (4). Discard gasket.

TA472420

b. Disassembly



1 Remove screw (1), flatwasher (2), idler arm cap (3) and spring pin (4).

2 Remove inner sleeve bearing (5), bearing spacer (6), outer sleeve bearing (7), idler arm retainer (8) and packing (9). Discard packing.

3 Remove from idler arm (10) eight screws (11), inner sleeve bearing (12), outer sleeve bearing (13), packing (14), two retainers (15), retainer (16), spindle (17), seal (18) and plug (19). Discard packing and seal.

c. Assembly

1 Remove plug (20) to release air from housing (21).

2 Reverse order of disassembly.

3 Replace two packings (14 and 9).

4 Replace seal (18).

5 Torque screw (1) to 320 lb-ft (432 Nm).

6 Torque eight screws (11) to 35 lb-ft (47 Nm).

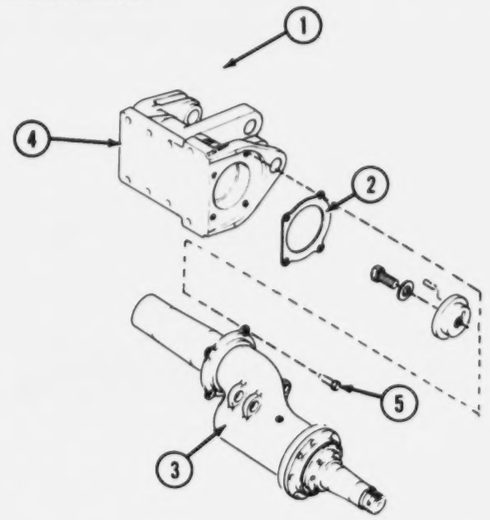
7 Pack idler arm (10) and idler arm housing (21) with GAA grease (Item 26, App. C).

TA472421

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-12. IDLER ARM ASSEMBLY - CONTINUED

d. Installation



1 Replace plug (1).

2 Replace gasket (2) and install idler arm assembly (3) on idler arm housing (4).

3 Install four screws (5) and torque to 90 lb-ft (122 Nm).

4 Connect track adjuster at idler arm assembly (ref. p. 10-25).

5 Install idler wheels and hub (ref. p. 10-28).

6 Install track (ref. p. 10-6).

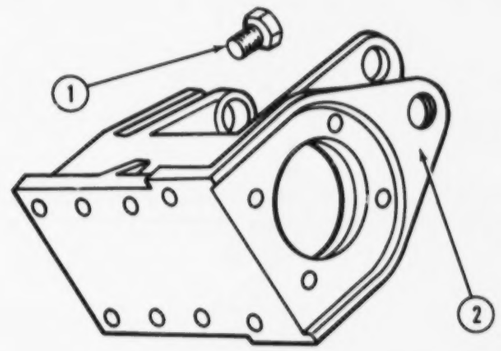
TA472422

10-13. IDLER ARM HOUSING

This task covers:

a. Removal b. Installation

a. Removal



1 Disconnect track (ref. p. 10-4).

2 Remove idler wheel and hub (ref. p. 10-28).

3 Disconnect track adjuster (ref. p. 10-25).

4 Remove idler arm assembly (ref. p. 10-32).

5 Remove eight screws (1) and idler arm housing (2).

b. Installation

1 Install in reverse order of removal.

2 Torque eight screws (1) to 320 lb-ft.

TA472423

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-14. SHOCK ABSORBER

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Special Tools
Shock absorber puller (Item 16, App. B)

Materials/Parts
Cotter pins (2), Seals (2)

a. Removal

1 Remove cotter pin (1), nut (2) and washer (3). Discard cotter pin.

2 Screw shock absorber puller on threaded end of bearing. Turn screw head with wrench to pull shock absorber from arm spindle on mount.

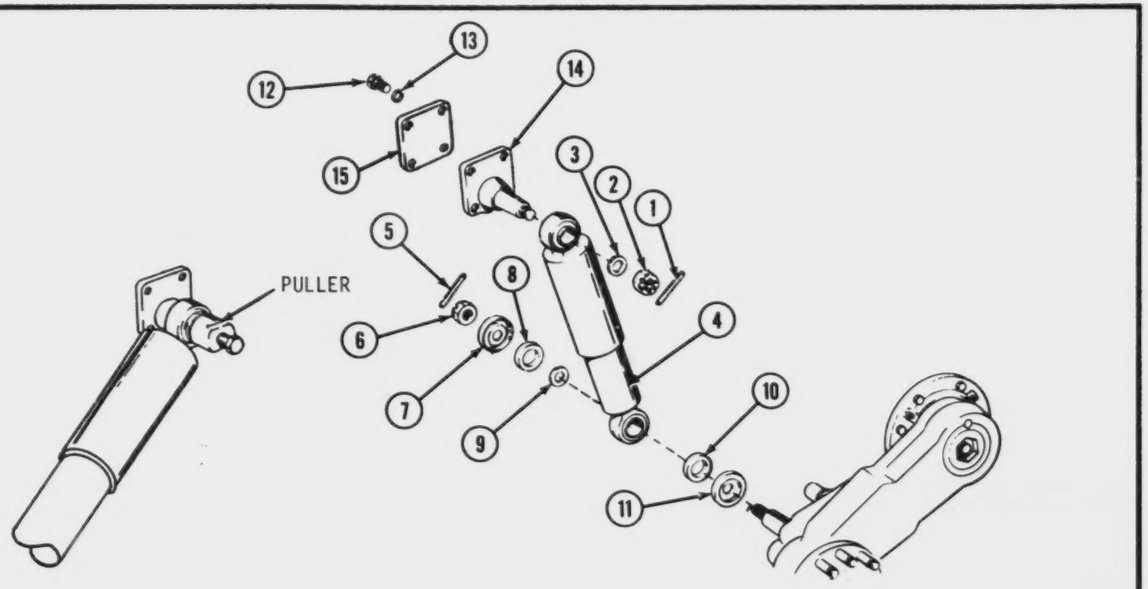
3 Remove top end of shock absorber (4) from mount. Use puller if required.

4 Remove cotter pin (5), nut (6), retainer (7), seal (8) and washer (9). Discard cotter pin and seal.

5 Remove bottom end of shock absorber (4). Use puller if required.

6 Remove seal (10) and retainer (11). Discard seal.

7 Remove four screws (12) and four washers (13) from shock absorber mount (14). Remove mount and plate (15) (front shock absorbers only).



b. Installation

1 Install in reverse order of removal.

2 Replace seals (10) and (8).

3 Torque nuts (6) and (2) to 150 lb-ft (203 Nm). Torque screw (12) to 90 lb.-ft.

4 Replace cotter pins (1) and (5).

TA472424

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION II. SUSPENSION SYSTEM - CONTINUED

10-15. SHOCK ABSORBER BEARING

This task covers:

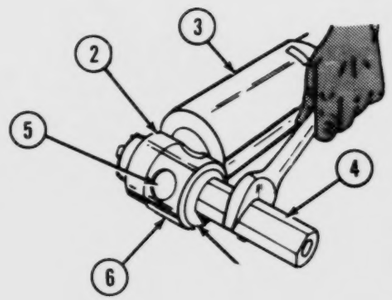
a. Removal b. Installation

INITIAL SET-UP

Special Tools
Bearing remover and puller (Item 15, App. B)

Materials/Parts
Bearing

a. Removal

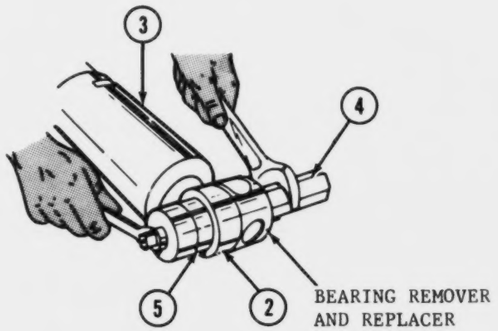


1 Install remover and replacer tool in shock absorber eye (2) of shock absorber (3).

2 Turn puller (4) clockwise to remove bearing (5). Bearing will be pulled into collar (6) of remover. Discard bearing.

TA472425

b. Installation



BEARING REMOVER AND REPLACER

1 Use fine mill file or stone to remove stake marks and burrs from inner surface of shock absorber eye (2).

2 Start bearing (5) into eye of shock absorber (3) by hand.

3 Insert remover and replacer tool (Item 15, Appendix B) through bearing (5).

4 Turn nut (4) clockwise to install bearing (5).

5 Stake bearing at three equally spaced points on both sides.

TA472426

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS

10-16. FINAL DRIVE SPROCKET AND HUB

This task covers:

a. Removal b. Installation

INITIAL SET-UP

Personnel Required
2

a. Removal

1 Disconnect track (ref. p. 10-4).

NOTE

Hub with inner and outer sprockets attached may be removed as an assembly by removing screws (4).

2 Remove ten nuts (1) and ten screws (2) from outer sprocket (3). Lift off sprockets.

WARNING

Hub (5) is very heavy. Use at least two men when removing and installing.

3 Remove eight screws (4) from hub (5). Insert two screws (4) in hub pilot holes. Tighten to pull hub (5) away from drive assembly (7). Lift off hub and inner sprocket (6) from drive assembly (7).

4 Remove ten nuts (8) and ten screws (9) holding hub (5) to inner sprocket (6). Lift off hub.

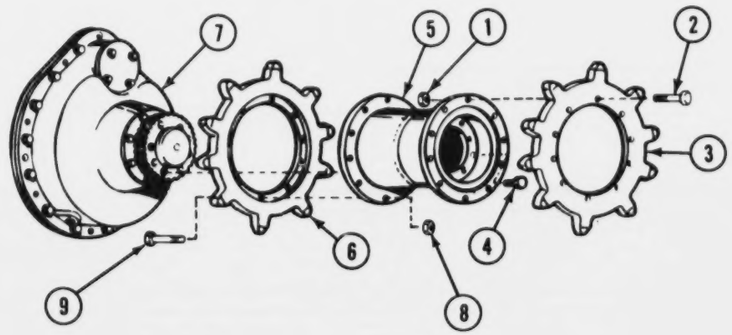
b. Installation

1 Place inner sprocket (6) on sprocket hub (5) and install ten screws (9) and ten nuts (8), locking sprocket to hub. Torque screws to 90 lb-ft (122 Nm).

2 Place hub on final drive assembly (7) and install eight screws (4) holding hub to final drive assembly. Torque screws to 450 lb-ft (607 Nm).

3 Place outer sprocket (3) on hub and install ten screws (2) and ten nuts (1). Torque screws to 90 lb-ft (121.5 Nm).

4 Connect track (ref. p. 10-4).



TA472427

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS - CONTINUED

10-17. FINAL DRIVE ASSEMBLY

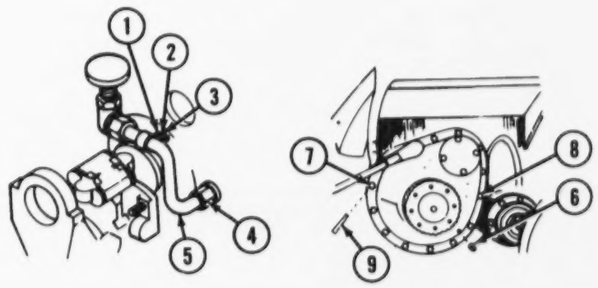
This task covers:

a. Removal b. Inspection c. Installation

INITIAL SET-UP

Special Tools	Materials/Parts	Personnel Required
Eye bolt (Item 1, App. B)	Zinc chromate paste (Item 54, App. C)	2
Hoist, Lifting sling (Item 5, App. B)	Oil (Item 32, App. C)	
Guide pins (2) (Item 3, App. B)		

a. Removal



NOTE

Final drive and bearing retaining nut may be inspected while installed in the vehicle. Refer to inspection procedure on page 10-43.

1 Remove final drive sprocket and hub (ref. p. 10-40).

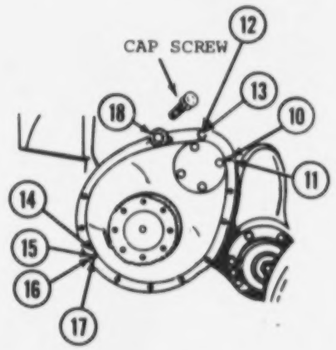
2 Remove screw (1), washer (2) and clamp (3).

3 Unscrew tube hex nut connector (4).

4 Remove vent tube (5).

5 Remove drain plug (6) and drain oil from final drive assembly.

TA472428



6 Remove two screws (7) and two lockwashers (8).

7 Install two guide pins (9) in screw holes (7).

8 Remove six screws (10) and six lockwashers (11). Leave top screw (12) and lockwasher (13) in place.

9 Remove five screws (14), five lockwashers (15), five flatwashers (16) and five nuts (17).

10 Remove cap screw at top of housing and install lifting eye bolt (18).

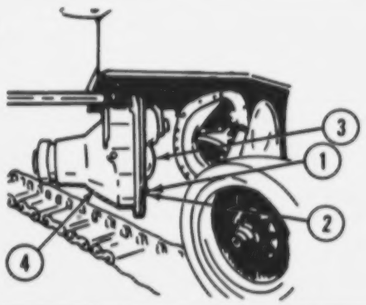
11 Attach lifting sling to eye bolt (18) and to hoist.

12 Remove top screw (12) and lockwasher (13).

13 Slide final drive assembly (19) away from vehicle.

14 Remove two guide pins (9).

b. Inspection



1 Remove 12 screws (1), 12 lockwashers (2), end cover (3) and gaskets (4).

2 Inspect retaining nut. If there are any visual signs of loose nut or sheared cotter pin, remove and replace final drive. Notify support maintenance.

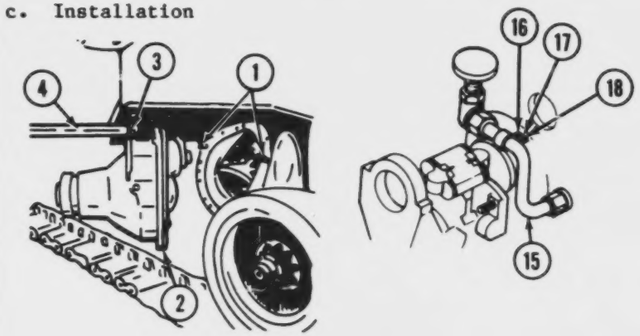
3 Inspect gasket (4). Replace if worn or deteriorated.

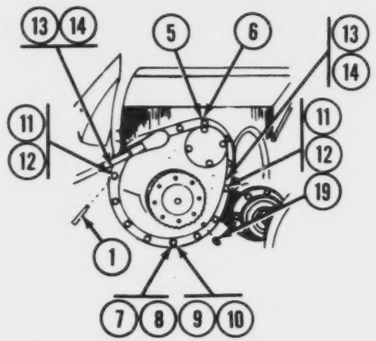
4 Install gasket (4) and end cover (3) with 12 lockwashers (2) and 12 screws (1). TA472429

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS - CONTINUED

10-17. FINAL DRIVE ASSEMBLY - CONTINUED

c. Installation





1 Install guide pins (1).

2 Coat contact surfaces of hull and final drive assembly (2) with zinc chromate paste before installation.

3 Install eye bolt (3) and lifting sling (4) on final drive assembly (2). Slide final drive assembly (2) over guide pins (1).

4 Install top screw (5) and lockwasher (6) and a bottom screw (7), lockwasher (8), flatwasher (9) and nut (10) near bottom of final drive.

5 Remove guide pins (1), lifting eye bolt (3) and lifting sling (4).

6 Install remaining screws (11), lockwashers (12), flatwashers (13) and nuts (14). Torque screws to 290 lb-ft (392 Nm).

7 Install vent tube (15), clamp (16), screw (17) and washer (18).

8 Install drain plug (19). Fill final drive assembly with oil (ref. LO 9-2350-311-12).

9 Install sprocket and hub (ref. p. 10-40).

TA472430

10-18. UNIVERSAL JOINTS

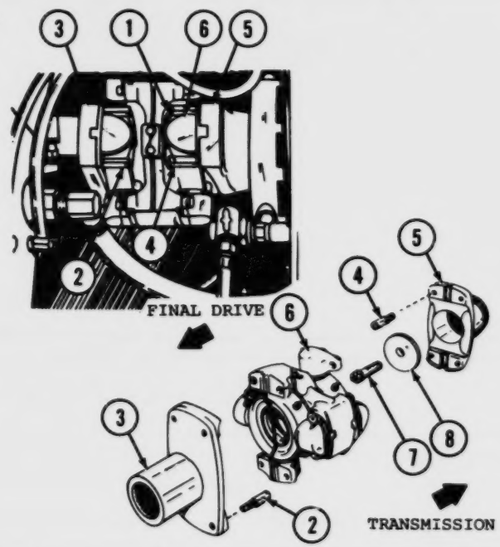
This task covers:

a. Removal b. Disassembly c. Inspection and Repair d. Assembly e. Installation

INITIAL SET-UP

Material/Parts
Lockwire
GAA Grease (Item 23, App. B)

a. Removal



1 Open transmission access doors.

2 Remove lockwires (1).

NOTE

If flange and adapter screws are inaccessible, place transmission shift lever in neutral (N) and push or tow vehicle until universal joint rotates sufficiently to allow access to screws.

3 Remove four screws (2) at flange assembly (3) and four screws (4) at adapter (5).

4 Slide flange assembly (3) toward final drive, and adapter group toward transmission. Lift out spider, plate, bumper and retainer group (6).

5 Slide flange assembly (3) off final drive.

6 Remove screw (7) and plate (8). Slide adapter (5) off transmission.

TA472533

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS - CONTINUED

10-18. UNIVERSAL JOINTS - CONTINUED

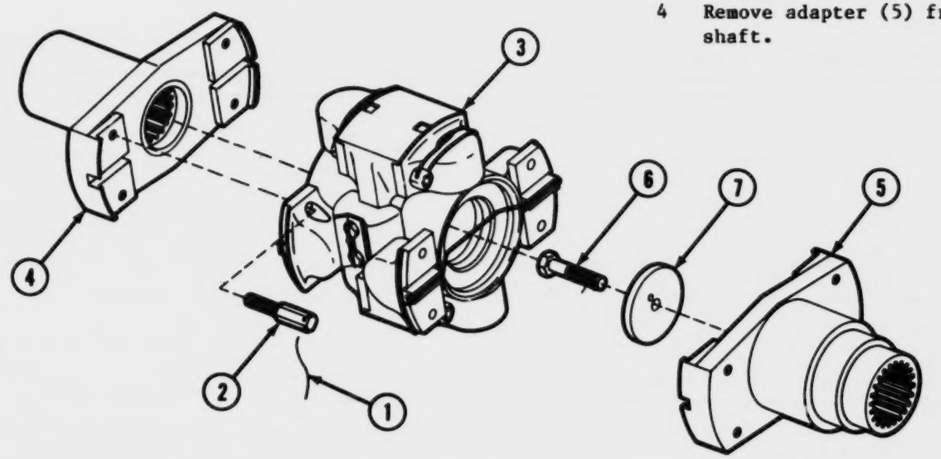
a. Disassembly

1 Remove four lockwires (1) and eight screws (2).

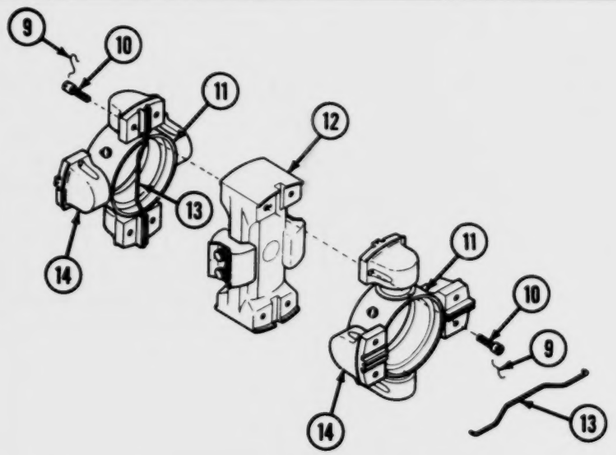
2 Separate joint assembly (3) from flange (4) and adapter (5).

3 Remove bolt (6) and adapter lock plate (7) from transmission splined shaft.

4 Remove adapter (5) from transmission splined shaft.



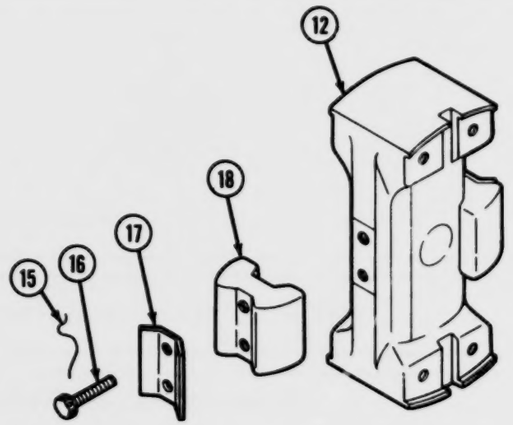
TA472534



5 Remove flange final drive (4) from final drive splined shaft. Flange plug is installed in flange final drive. Do not remove.

6 Remove four lockwires (9) and eight screws (10).

7 Separate two journal assemblies (11) from center plate (12).



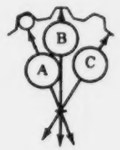
8 Remove two lockwires (15), four screws (16), two bumper retainers (17) and two bumpers (18) from center plate (12).

TA472535

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS - CONTINUED

10-18. UNIVERSAL JOINTS - CONTINUED

c. Inspection and Repair



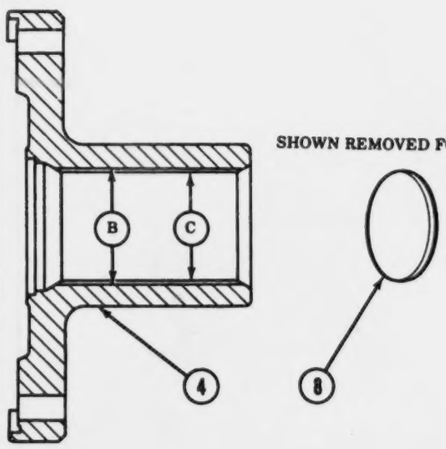
NOTE

For definition of repair and inspection symbols, refer to page 2-5.

1 Inspect flange (4) for cracks, distortion, broken or missing splines. Replace if cracked, distorted, or if splines are broken or missing.

NOTE

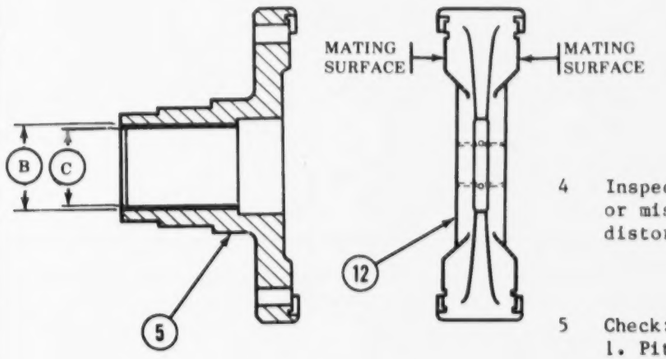
2.0490 to 2.0500 pitch diameter is the reading over two pins (0.1406 inch diameters).



	Size and Fit of New Parts	Wear Limits
2 Check:		
1. Pitch diameter (A)	2.0490 to 2.0500	2.0515
2. Major diameter (B)	2.3333 to 2.3383	2.3405
3. Minor diameter (C)	2.1800 to 2.1825	2.1850

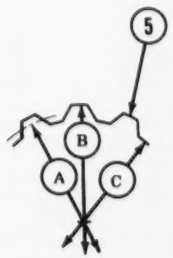
3 Inspect flange plug (8) for damage or distortion. Plug must provide water- and oil-tight seal. Replace flange (4) if plug is damaged or distorted.

TA472536



4 Inspect adapter (5) for cracks, distortion, broken or missing splines. Replace adapter if cracked or distorted, or if splines are broken or missing.

	Size and Fit of New Parts	Wear Limits
5 Check:		
1. Pitch diameter (A)	Ref. TM 9-2520-234-35	
2. Major diameter (B)	3.8800 to 3.8850	3.8780
3. Minor diameter (C)	3.3460 to 3.3470	3.3445
4. Finish (splines)	25 polished	



6 Check center plate (12) concentricity of mating surfaces with center bore, insuring TIR (Total Indicator Reading) is within 0.0040.

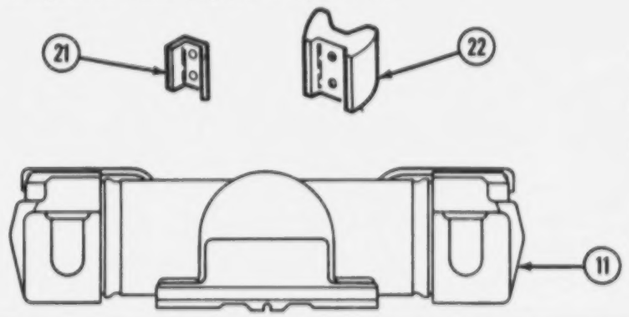
Inspect for distortion, insuring mating surfaces square to within 0.0040 TIR.

TA472537

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS - CONTINUED

10-18. UNIVERSAL JOINTS - CONTINUED

c. Inspection and Repair - Continued

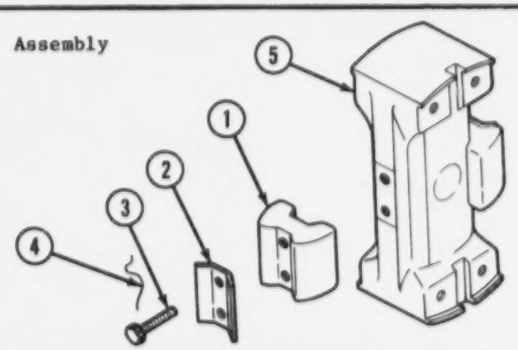


7 Replace bumper retainer (21) as appropriate.

8 Replace bumper (22) as appropriate.

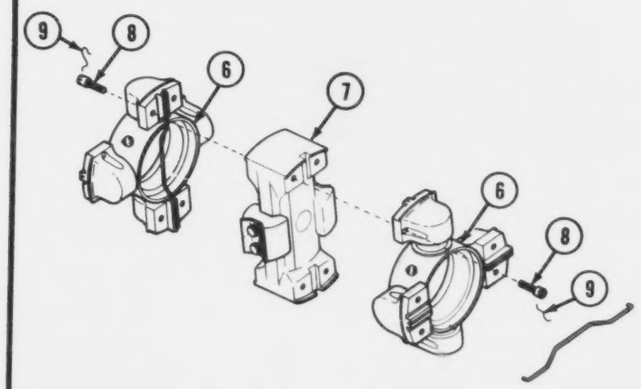
9 Check two journal assemblies (11) for damage or defects. Check for play between bearing caps and spider. Replace universal if play is excessive.

d. Assembly



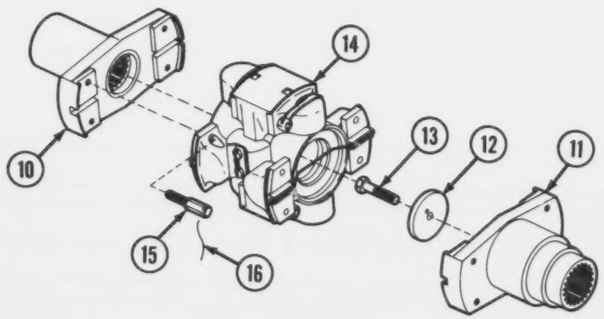
1 Install two bumpers (1), two bumper retainers (2), four screws (3) and two new lockwires (4) onto center plate (5).

TA472538



2 Reconnect by placing together two journal assemblies (6) and the center plate (7).

3 Install eight screws (8) and four new lockwires (9).



4 Install flange final drive (10) back onto final drive splined shaft, with flange plug installed inside.

5 Install adapter (11) back onto transmission splined shaft.

6 Install adapter lock plate (12) and bolt (13) onto transmission splined shaft.

7 Connect joint assembly (14) to adapter (11) and flange (10).

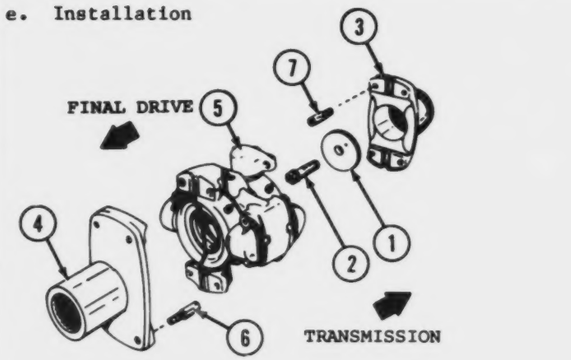
8 Install eight screws (15) and four new lockwires (16).

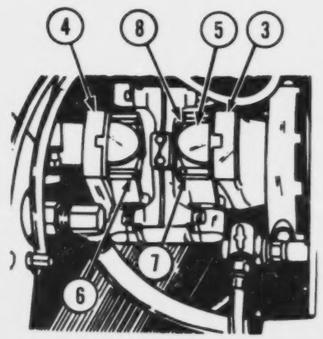
TA472539

TRACKS, SUSPENSION SYSTEM, FINAL DRIVES AND UNIVERSAL JOINTS - SECTION III. FINAL DRIVE AND UNIVERSAL JOINTS - CONTINUED

10-18. UNIVERSAL JOINTS - CONTINUED

e. Installation





1 Install plate (1) and screw (2) into adapter (3) and slide on transmission.

2 Slide flange assembly (4) on final drive.

3 Hold spider, plate, bumper and retainer group (5) and mate with adapter (3) and flange assembly (4).

CAUTION

U-joint screws must be torqued and secured with lockwire to prevent unsafe driving conditions and damage to the vehicles.

4 Install eight screws (6 and 7). Torque screws to 90-100 lb-ft (121.9 to 135.6 Nm). Install lockwires (8).

5 Close transmission access doors.

TA472540

CHAPTER 11
HULL-RELATED COMPONENTS

GENERAL

This chapter illustrates and defines procedures for removal, disassembly, assembly, installation, inspection and adjustment of hull-related components.

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HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES

11-1. DRIVER'S SEAT ASSEMBLY

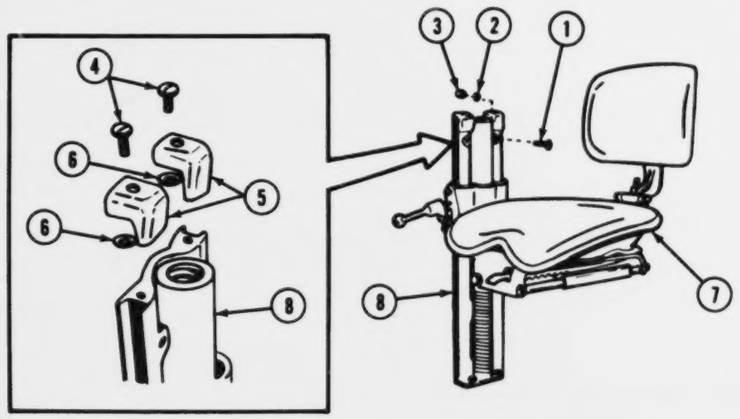
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Material/Parts
Cotter pins (3)

a. Removal



1 Remove two screws (1), two washers (2) and two plug nuts (3) from driver's seat.

2 Remove two screws (4), two pads (5) and two flatwashers (6).

3 Lift seat assembly (7) off vertical support (8).

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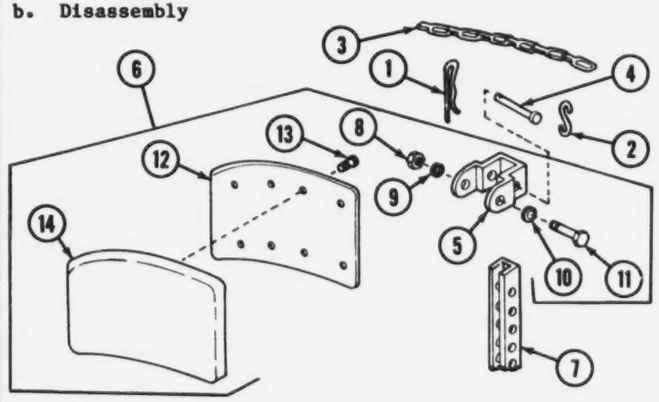
b. Disassembly



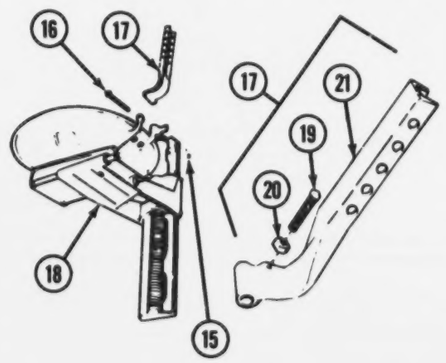
1 Remove cotter pin (1), hook (2), chain (3) and headed pin (4) from bracket (5).

2 Remove backrest assembly (6) from seat support bracket (7).

3 Remove locknut (8), two flatwashers (9) and (10), and screw (11) from bracket (5).

4 Remove bracket from backrest frame (12).

5 Remove eight screws (13) from backrest frame (12) to separate backrest cushion (14).



6 Remove locknut (15), screw (16) and backrest support assembly (17) from seat support bracket (18).

7 Remove adjusting screw (19) and nut (20) from backrest support (21).

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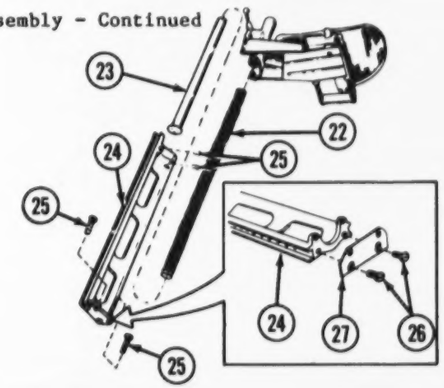
HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-1. DRIVER'S SEAT ASSEMBLY - CONTINUED

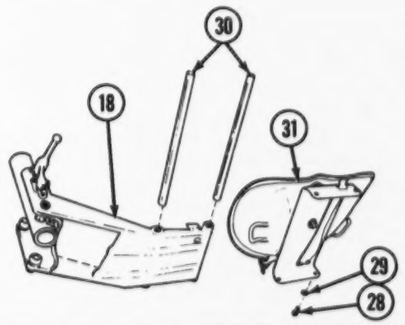
b. Disassembly - Continued



8 Remove spring (22) and vertical guide (23) from vertical support (24).

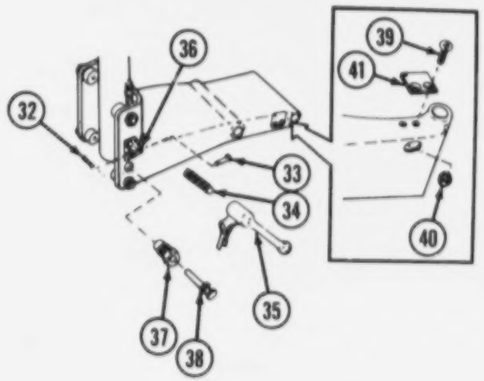
9 Remove four screws (25) and vertical support (24) from driver's compartment.

10 Remove two screws (26) and base plate (27) from vertical support (24).



11 Remove four screws (28), four flatwashers (29), two horizontal slide bars (30) and seat support bracket (18) from seat assembly (31).

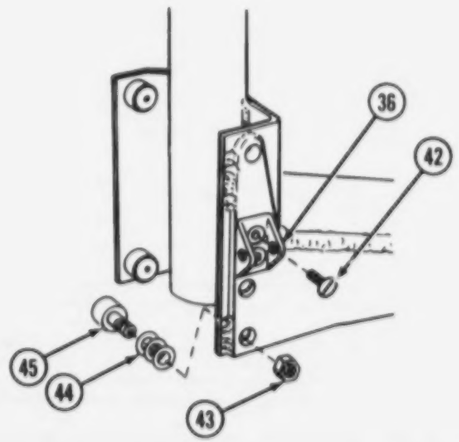
TA472435



12 Remove cotter pin (32), headed pin (33), spring (34) and vertical adjusting lever (35) from vertical adjusting lever bracket (36) and seat support bracket (18). Discard cotter pin.

13 Remove threaded sleeve (37) and plunger (38).

14 Remove two screws (39), two nuts (40) and lock plate (41).



15 Remove two screws (42) and adjusting lever bracket (36).

16 Remove four nuts (43), shims (44) and four cam followers (45).

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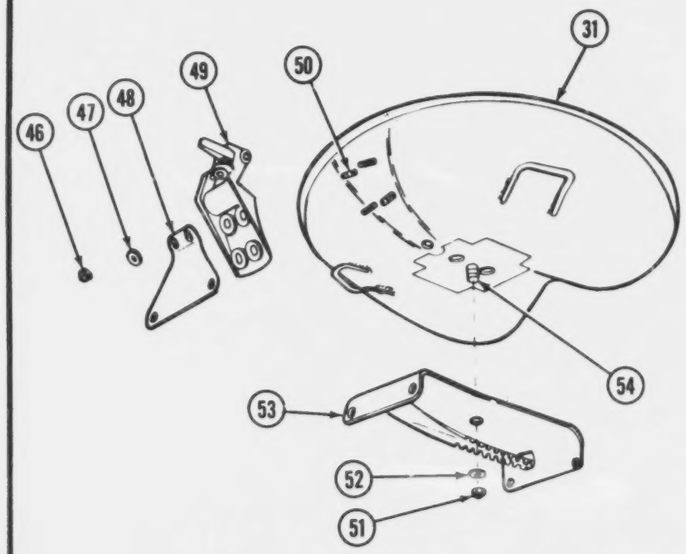
HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-1. DRIVER'S SEAT ASSEMBLY - CONTINUED

b. Disassembly -- Continued



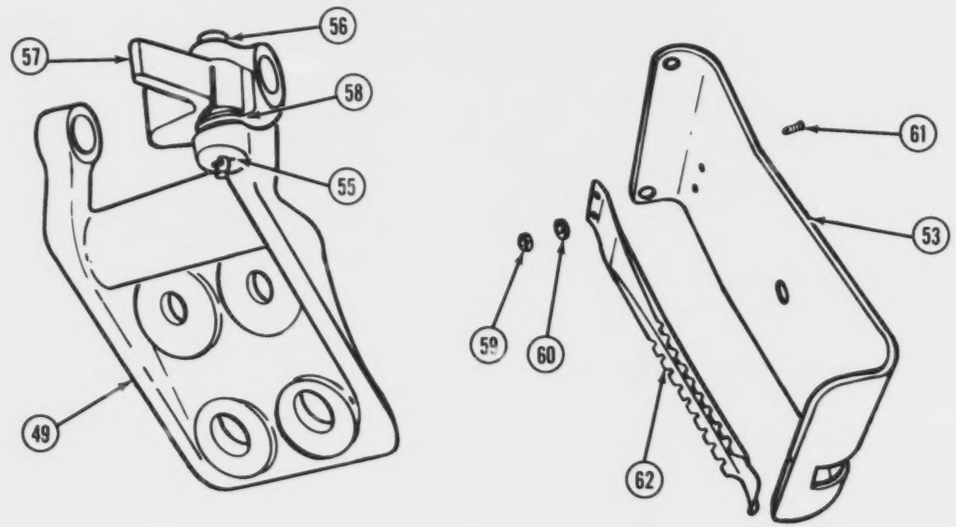
17 Remove four nuts (46), four washers (47), reinforcement bracket (48) and backrest bracket group (49) from seat assembly (31) at mounting studs (50).

18 Remove nut (51), lockwasher (52) and horizontal adjusting group (53) from seat assembly (31) at mounting stud (54).

TA472437

19 Remove cotter pin (55) from headed pin (56) and release pawl (57) and spring (58) from backrest group (49).

20 Remove two nuts (59), two flatwashers (60), two screws (61) and horizontal adjusting bar (62) from horizontal adjusting group (53).



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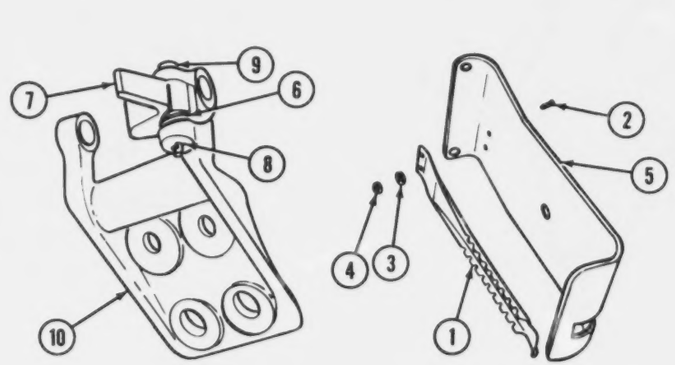
HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-1. DRIVER'S SEAT ASSEMBLY - CONTINUED

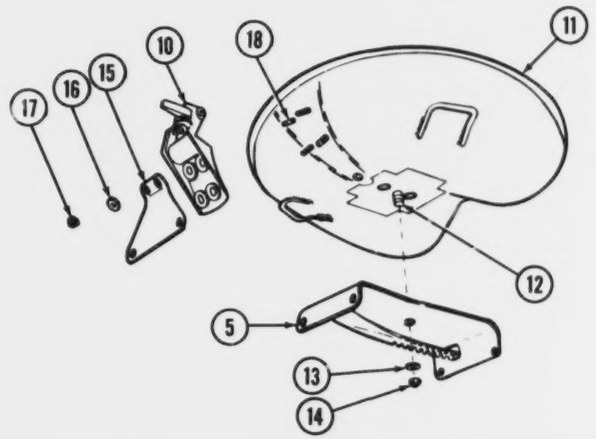
c. Assembly

1 Install horizontal adjusting bar (1) with two screws (2), two flatwashers (3) and two nuts (4) onto horizontal adjusting group (5).

2 Position spring (6) between pawl (7) and backrest bracket group (10). Install headed pin (9) and secure with new cotter pin (8).

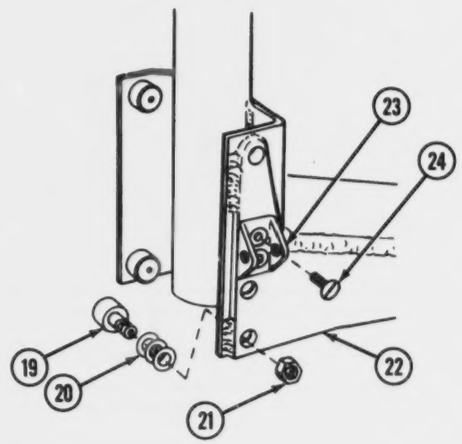


TA472439



3 Install horizontal adjusting gruop (5) onto seat assembly (11) at mounting stud (12) with lockwasher (13) and nut (14).

4 Install backrest bracket group (10), reinforcement bracket (15), four washers (16) and four nuts (17) onto seat assembly (12) at mounting studs (18).



NOTE

Install shims as required to provide a snug fit between cam follower and seat support bracket.

5 Install four cam followers (19), shims (20) and four nuts (21) to seat support bracket (22).

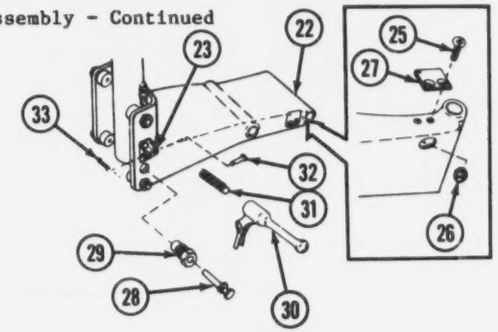
6 Install adjusting lever bracket (23) by installing two screws (24).

TA472440

HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-1. DRIVER'S SEAT ASSEMBLY - CONTINUED

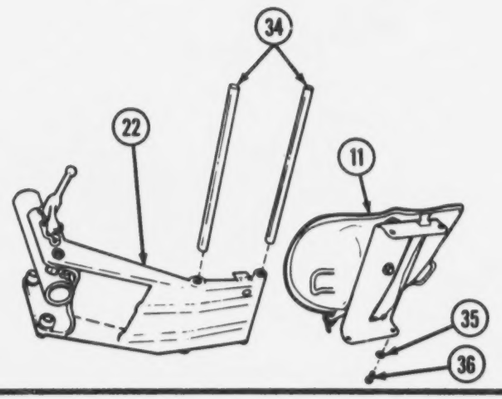
c. Assembly - Continued



7 Install two screws (25), two nuts (26) and lock plate (27).

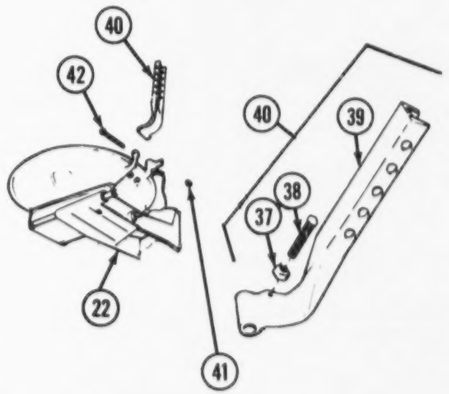
8 Install plunger (28) and threaded sleeve (29).

9 Install vertical adjusting lever (30), spring (31), headed pin (32) and new cotter pin (33) onto vertical adjusting lever bracket (23) and seat support bracket (22).



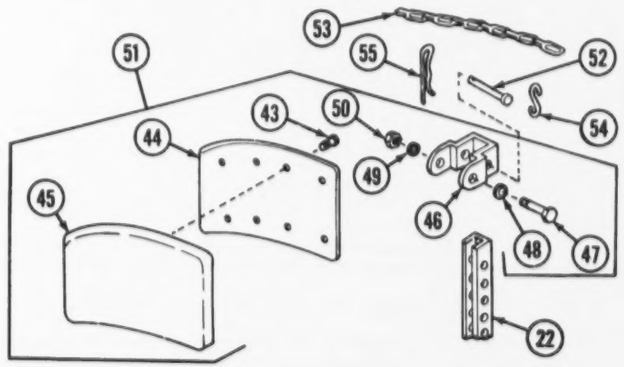
10 Install seat support bracket (22), two horizontal slide bars (34), four flatwashers (35) and four screws (36) onto seat assembly (11).

TA472441



12 Install nut (37) and adjusting screw (38) onto backrest support (39).

13 Install backrest support assembly (40) with locknut (41) and screw (42) onto seat support bracket (22).



14 Install eight screws (43) onto backrest frame (44) to attach backrest cushion (45).

15 Attach bracket (46) to backrest frame (22) with screw (47), two flatwashers (48) and (49) and locknut (50).

16 Install backrest assembly (51) onto backrest support assembly (40).

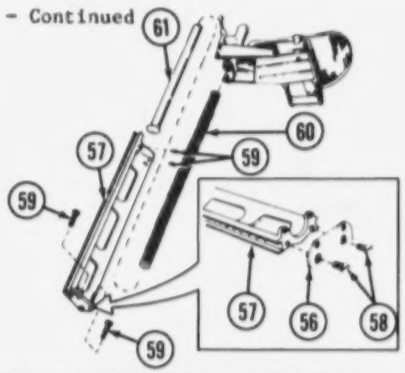
17 Install headed pin (52), chain (53), hook (54) and new cotter pin (55) onto bracket (46).

TA472442

HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-1. DRIVER'S SEAT ASSEMBLY - CONTINUED

c. Assembly - Continued

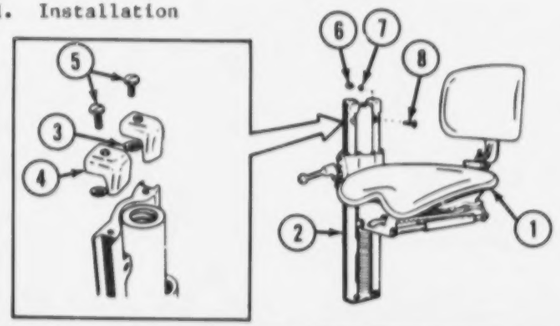


18 Install base plate (56) on vertical support (57) with two screws (58).

19 From driver's compartment, install vertical support (57) with four screws (59).

20 Install spring (60) over vertical guide (61) onto vertical support (57).

d. Installation



1 Place seat assembly (1) onto vertical support (2).

2 Install two flatwashers (3), two pads (4) and two screws (5).

3 Install two plug nuts (6), two washers (7) and two screws (8) into driver's seat.

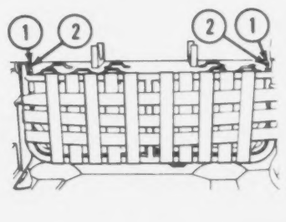
TA472443

11-2. CANNONEERS' SEAT ASSEMBLY

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

a. Removal

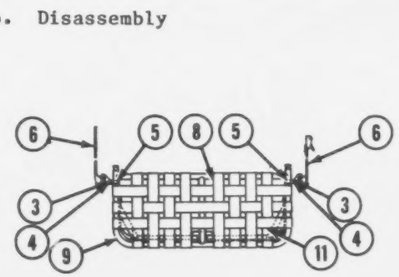


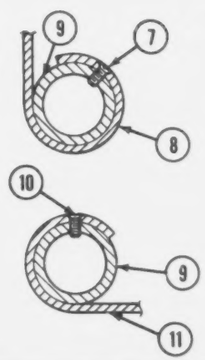
1 Place seat in folded down position.

2 Remove two snap rings (1) and two pins (2) from seat.

3 Remove seat assembly.

b. Disassembly





1 Remove two nuts (3) and two screws (4) from two clamps (5).

2 Remove two clamps (5) and two safety belts with plates (6).

3 Remove 16 screws (7) from short straps (8) and frame (9). Remove snort straps from frame.

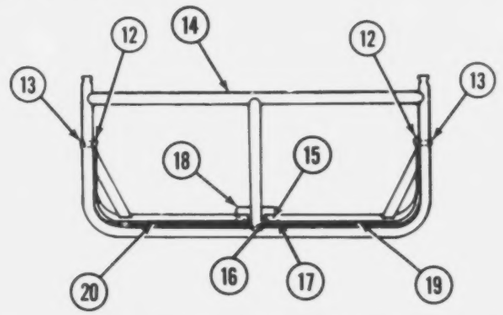
4 Remove six screws (10) from long straps (11) and frame (9). Remove long straps from frame.

TA472444

HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-2. CANNONEERS' SEAT ASSEMBLY - CONTINUED

b. Disassembly - Continued

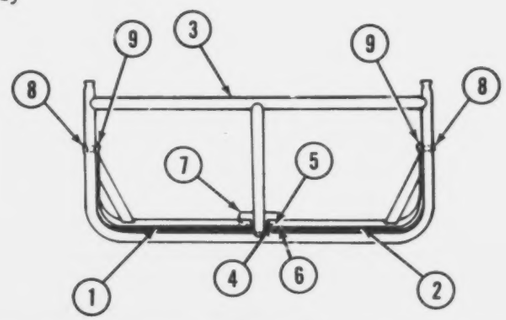


5 Remove two snap rings (12) and two pins (13) from bracket (14) and frame.

6 Remove four nuts (15), four screws (16) and four lockwashers (17) from the support bracket connector (18).

7 Remove right support bracket (19) and left support bracket (20) from frame (9).

c. Assembly

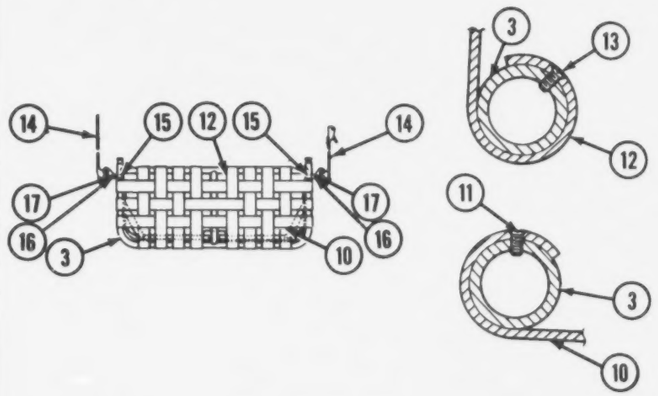


1 Install right support bracket (1) and left support bracket (2) onto frame (3).

2 Install four screws (4), four lockwashers (5) and four nuts (6) in the support bracket connector (7).

3 Install two pins (8) and two snap rings (9) in brackets (1) and (2) and frame (3).

TA472445



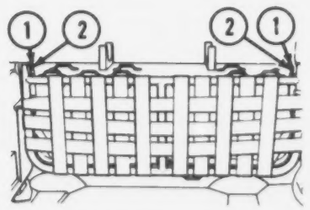
4 Install long straps (10) on frame (3) using six screws (11).

5 Install short straps (12) on frame (3) using 16 screws (13).

6 Install two safety belts with plates (14) using two clamps (15).

7 Install two screws (16) and two nuts (17) in two clamps (15).

d. Installation



1 To install cannoneer's seat, position seat in the folded down position.

2 Install two pins (1) and two snap rings (2).

TA472446

HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-2.1 M109A4 CANNONEER'S SEAT ASSEMBLY

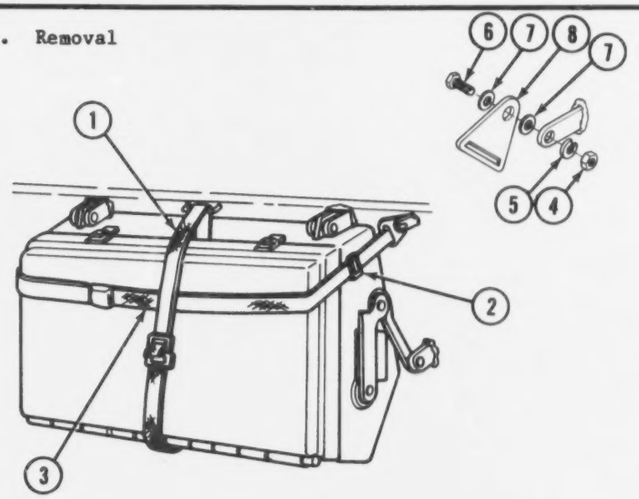
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Materials/Parts
Rivets (8)

a. Removal



NOTE

The following procedure may be used both for the left and right seat assemblies.

1 Remove strap (1).

2 Remove two slides (2) and belt (3).

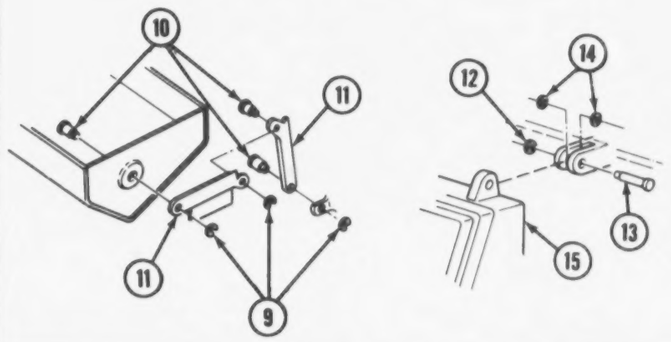
NOTE

The left seat assembly only has one nut (4).

3 Remove two nuts (4) from right seat, one nut (4) from left seat, two lockwashers (5), two screws (6), four washers (7) and two anchors (8).

4 Place seat in upright position and support.

a. Removal - Continued

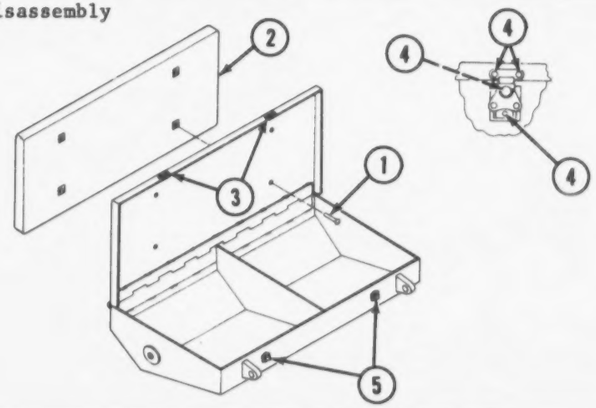


5 Remove three retaining rings (9), three pins (10) and two arms (11). Repeat for opposite side of seat.

6 Lower seat and support.

7 Remove two retaining rings (12),two pins (13), four washers (14) and seat assembly (15).

b. Disassembly



1 Remove four screws (1) and cushions (2).

NOTE

Remove fastener latch (3) and catch (5) only if damaged.

2 Drill out eight rivets (4) and remove two fastener latches (3) and catches (5).

c. Assembly

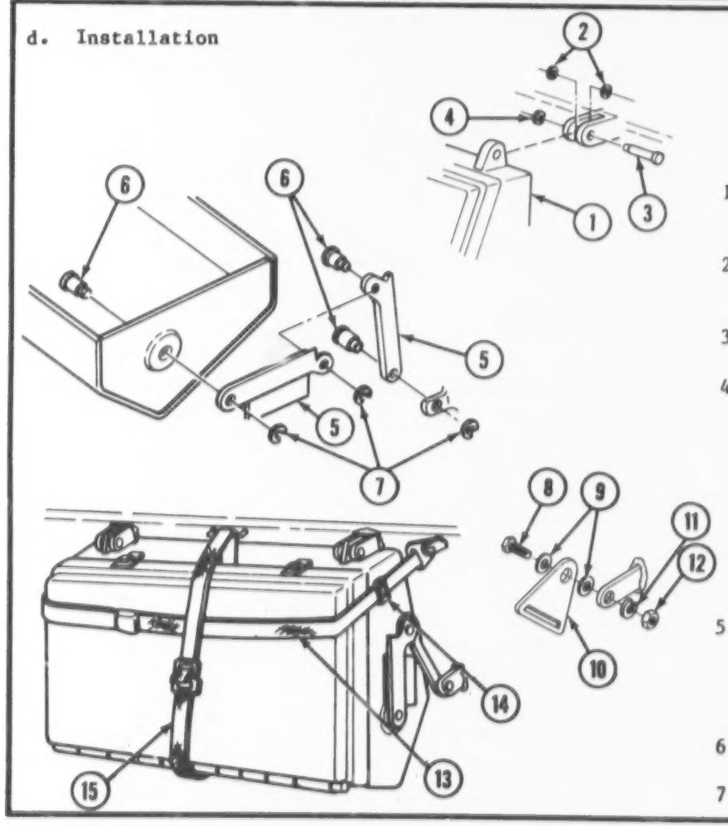
1 Install eight rivets (4).

2 Assemble in reverse order of disassembly.

HULL-RELATED COMPONENTS - SECTION I. DRIVER'S & CANNONEERS' SEAT ASSEMBLIES - CONTINUED

11-2.1. M109A4 CANNONEER'S SEAT ASSEMBLY - CONTINUED

d. Installation



NOTE

The following procedure may be used for both the left and right side seat assemblies.

1 Place cannoneer's seat (1) in the folded down position and support.

2 Install four washers (2), two pins (3) and two retaining rings (4).

3 Place seat in upright position and support.

4 Install two arms (5), three pins (6) and three retaining rings (7). Repeat for opposite side of seat.

NOTE

The left side seat assembly has only one nut (12).

5 Install two screws (8), four washers (9), two anchors (10), two lockwashers (11) and two nuts (12) on right seat, one nut (12) on left seat.

6 Install belt (13) and two slides (14).

7 Install strap (15).

HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES

11-3. DRIVER'S HATCH COVER AND LOCK COMPONENTS

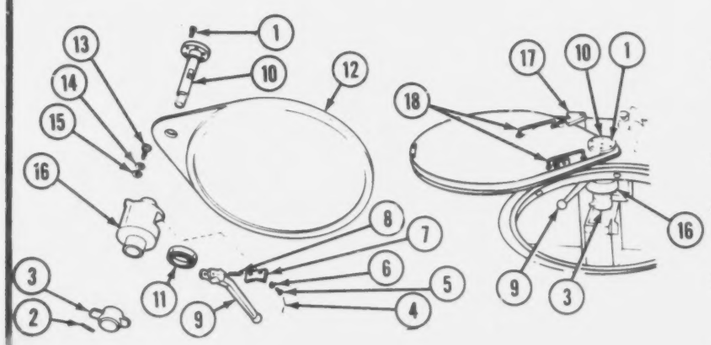
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Housing seal, Cotter pin, Spring washer, Cover seal, Sealant (Item 49, App. C), Lockwire

a. Removal



1 Remove six screws (1), spring pin (2) and chuck (3) from closed hatch cover assembly.

2 Remove lockwire (4), two screws (5), two lockwashers (6) and elevating cam (7). Discard lockwire.

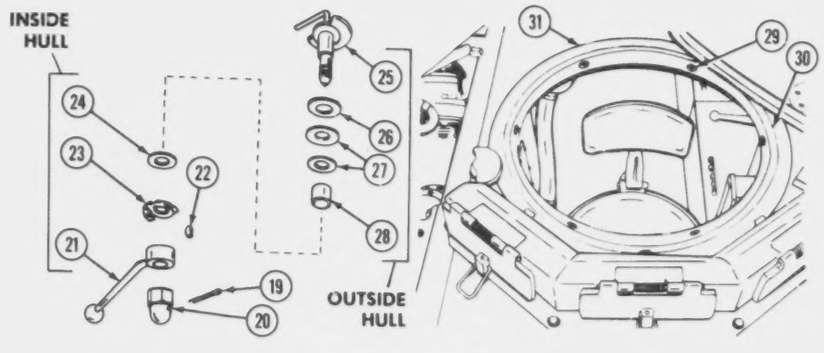
3 Punch out dowel pin (8).

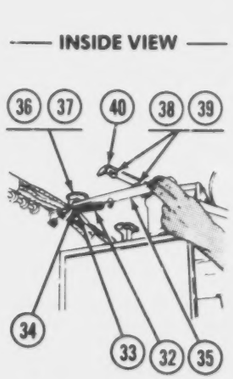
4 Remove elevating handle (9), shaft (10) and ball bearing (11).

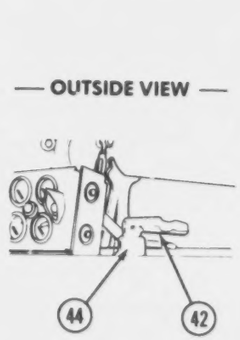
5 Swing latch (17) away from hatch cover (12) and lift off, using handles (18).

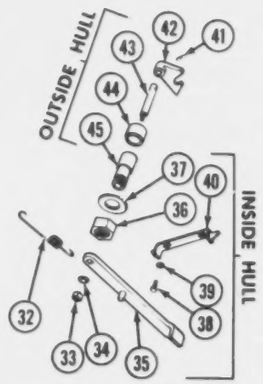
6 Remove three screws (13), three lockwashers (14), three flatwashers (15) and housing (16).

TA472447









7 Remove the following located in the hull: Cotter pin (19), adjusting nut (20), locking lever (21), woodruff key (22), lock spring (23) and washer (24).

8 Remove the following located outside the hull: Locking cam (25), spring washer (26), two flatwashers (27) and sleeve bearing (28). Discard spring washer.

9 Remove six screws (29) and seal (30).

10 Remove spring (32), nut (33), lockwasher (34) and handle (35).

11 Remove n .3o) and washer (37).

12 Remove two screws (38), two washers (39) and holding lever stop (40).

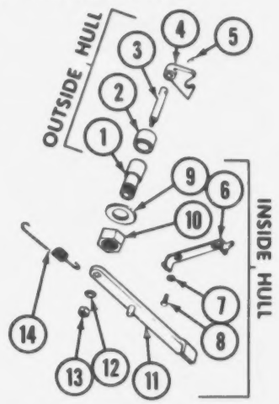
13 Remove spring pin (41), hatch stop (42), locking shaft (43), bumper (44) and locking sleeve (45).

TA472448

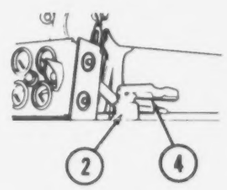
HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-3. DRIVER'S HATCH COVER AND LOCK COMPONENTS - CONTINUED

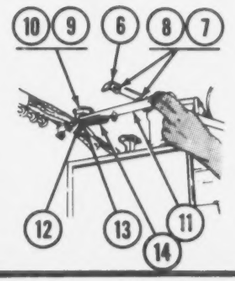
b. Installation



— OUTSIDE VIEW —



— INSIDE VIEW —



1 Install locking sleeve (1), bumper (2), locking shaft (3), hatch stop (4) and spring pin (5).

2 Install lever stop (6) using two washers (7) and two screws (8). Install washer (9) and nut (10).

3 Install handle (11) with lockwasher (12) and nut (13).

4 Install spring (14).

5 Scrape off old sealant and apply new sealant (Item 49, App. C) to seal ring (hatch opening) (15).

6 Install seal (16) with six screws (17). Insure a complete seal is made.

7 Install sleeve bearing (18), two flatwashers (19), new spring washer (20) and locking cam (21).

8 Install washer (22), lock spring (23), woodruff key (24), locking lever (25), adjusting nut (26) and new cotter pin (27).

9 Install ball bearing (28) in housing (29).

10 Install housing (29) to hull interior using three flatwashers (30), three lockwashers (31) and three screws (32).

11 Using handles (33), carefully lower hatch cover (34) into a closed position.

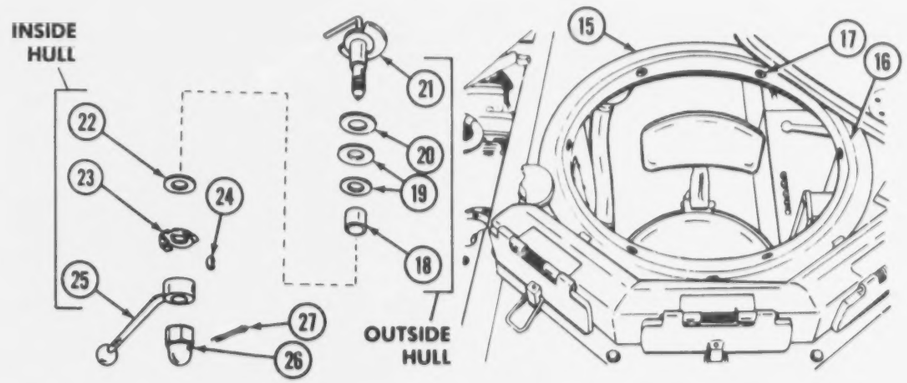
TA472449

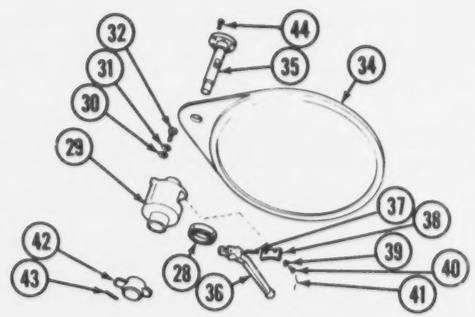
12 Install shaft (35) and elevating handle (36).

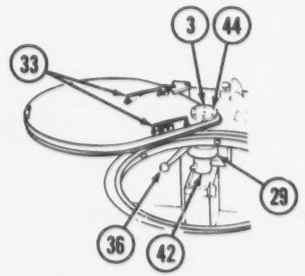
13 Drive in dowel pin (37).

14 Install elevating cam (38) with two lockwashers (39) and two screws (40). Install new lockwire (41).

15 Install chuck (42), spring pin (43) and six screws (44).







TA472450

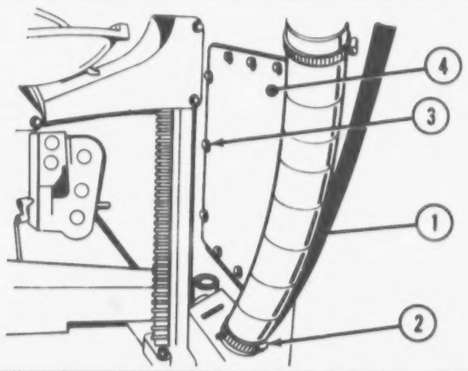
HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-4. ENGINE COMPARTMENT ACCESS COVER

This task covers:

a. Removal b. Installation

a. Removal



1 Disconnect hose assembly (1) at clamp (2). Move out of the way.

2 Remove 12 screws (3) and access cover (4).

b. Installation

WARNING

When installing engine compartment access cover, insure that all screws are secured. Carbon monoxide poisoning could result if cover is loose.

Install in reverse order of removal.

TA472451

11-4.1. BATTERY COMPARTMENT ACCESS DOORS

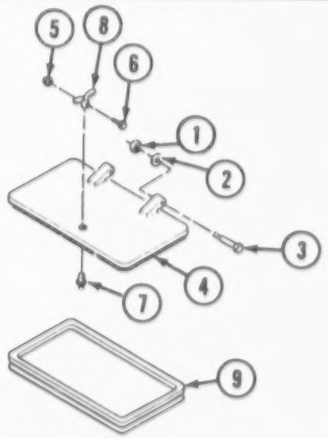
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Seal
Adhesive (Item 67, App. C)

a. Removal



NOTE

This procedure applies to either access door.

1 Remove two nuts (1), two washers (2) and two screws (3).

2 Carefully lift and remove battery compartment access door (4).

3 Remove nut (5), screw (6), stud (7) and handle (8).

4 Remove seal (9) only if torn, worn or deteriorating.

b. Installation

1 Replace seal (9) only if torn, worn or deteriorating.
2 Apply adhesive (Item 67, App. C) to new seal.
3 Install in reverse order of removal.

11-5. AIR INTAKE GRILLE

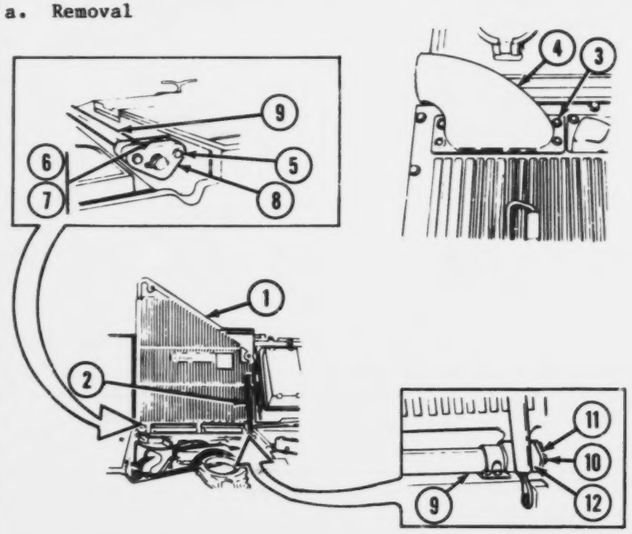
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Special Tools	Personnel Required
Eyebolt (2), Lifting sling, Hoist or wrecker	4

a. Removal



1 Open air intake grille (1). Secure with hold-open support (2) and pin.

2 Remove four screws (3) and exhaust deflector (4).

3 Remove two screws (5), two lockwashers (6) and two nuts (7), and anchor and shield (8) at right end of torsion bar (9).

4 Remove three screws (10), shield (11) and adapter (12) from left end of torsion bar (9).

WARNING

Grille is heavy. If hoist and sling are not available, at least four personnel are required to lift and move grille. If hoist and sling are not available, go to step 7.

TA472452

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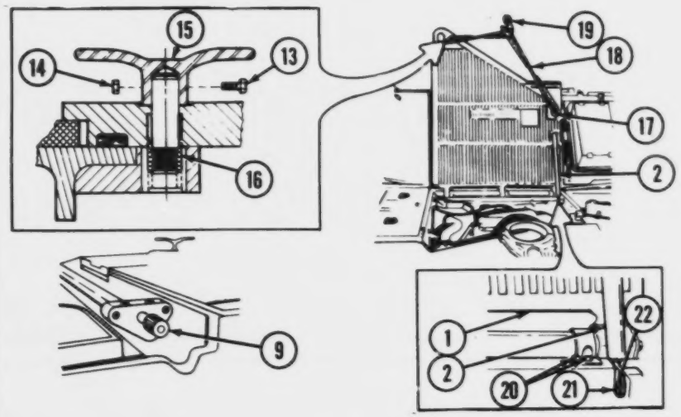
HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-5. AIR INTAKE GRILLE - CONTINUED

a. Removal - Continued



5 Remove two screws (13), two nuts (14), two handles (15) and two studs (16).

6 Attach two eyebolts (17), sling (18), and hoist (19) to grille. Take up slack in sling.

7 Remove torsion bar (9) from right side of vehicle.

8 Remove 12 screws (20). Remove screw (21) and flatwasher (22) from hold-open support (2).

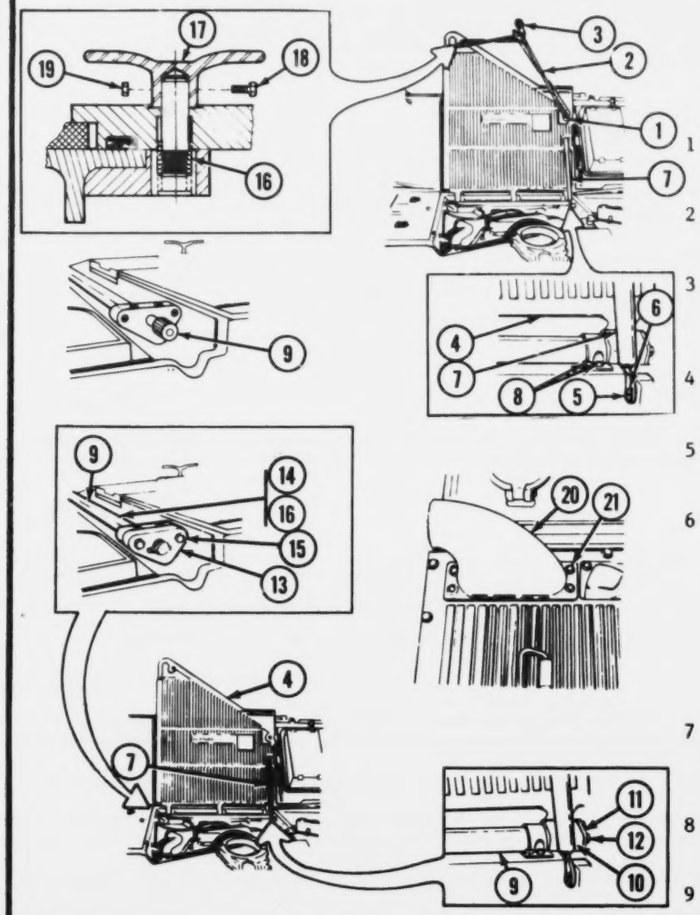
9 Lift air intake grille (1) off vehicle.

b. Installation

WARNING

Grille is heavy. If hoist and sling are not available, at least four personnel are required to lift and move grille.

TA472453



NOTE

- Cab must be traversed 90° before installing air intake grille.
- Follow step 1 only if hoist and sling are being used.

1 Attach two eyebolts (1), sling (2) and hoist (3) to air intake grille (4).

2 Place air intake grille (4) onto vehicle in open position. Secure in open position.

3 Install flatwasher (5) and screw (6) in hold-open support (7). Install 12 screws (8).

4 Install torsion bar (9) with grille (4) at 90-95° in a no-load condition.

5 Install adapter (10), shield (11) and three screws (12) at left end of torsion bar (9).

6 Install anchor and shield (13), two lockwashers (14), two screws (15) and two nuts (16) at right end of torsion bar (9).

NOTE

Follow step 7 only if hoist, sling and eyebolts are being used.

7 Secure grille with hold-open support (7) and pin and remove hoist (3), sling (2) and two eyebolts (1).

8 Install two studs (16), two handles (17), two screws (18) and two nuts (19).

9 Install exhaust deflector (20) and four screws (21).

TA472454

HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-6. DRAIN COVERS AND PLUGS

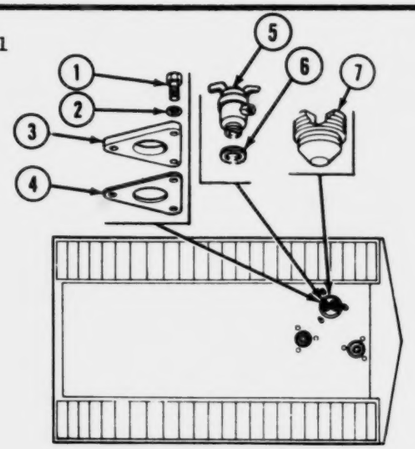
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Gaskets (4)

a. Removal



UNDERSIDE OF VEHICLE SHOWN

WARNING

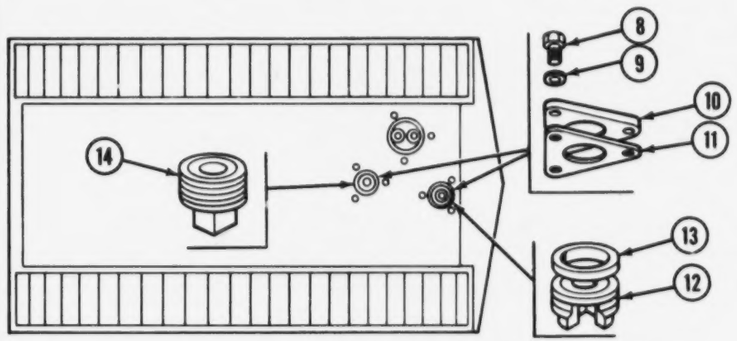
Allow engine to cool before removing engine coolant drain plug, engine oil drain plug and transmission drain plug. Hot fluids will cause severe burns.

1 Remove three screws (1), three washers (2), large cover (3) and gasket (4). Discard gasket.

2 Remove engine coolant drain plug (5) and gasket (6). Discard gasket.

3 Remove fuel drain plug (7).

TA472455



UNDERSIDE OF VEHICLE SHOWN

4 Remove six screws (8), six washers (9), two small covers (10) and gasket (11). Discard gasket.

5 Remove transmission oil drain plug (12) and gasket (13). Discard gasket.

6 Remove engine oil drain plug (14).

b. Installation

1 Install in reverse order of removal.

2 Replace gaskets (4), (6), (11) and (13).

TA472456

HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-6.1. SUBFLOOR DRAIN PLUGS -M109A4

This task covers:

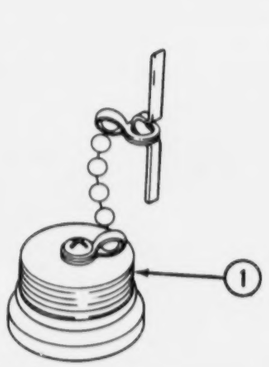
a. Removal/Disassembly b. Assembly/Installation

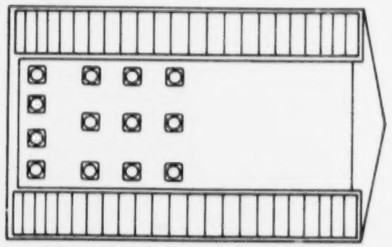
INITIAL SET-UP

Materials/Parts
Preformed packings (as required)
Sealing compound (Item 46, App. C)

Tools
Automotive Maintenance
Common No. 1 Tool Kit
SC 4910-95-CL-A74

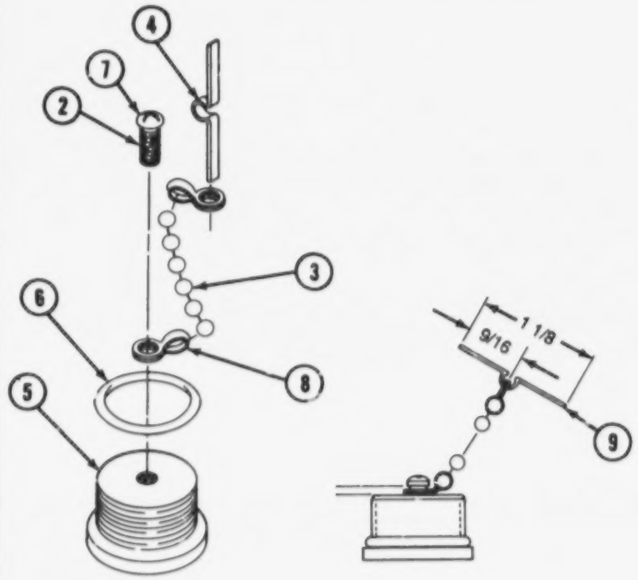
a. Removal/Disassembly





LOCATION OF SUBFLOOR DRAINS
UNDERSIDE OF VEHICLE SHOWN

1 Remove 13 drain plug assemblies (1).



2 Disassemble drain plug assembly by removing screw (2), chain (3) and cotter pin (4) from drain plug (5).

3 Remove preformed packing (6).

b. Assembly/Installation

1 Apply sealing compound (Item 46, App. C) to screw (2).

2 Assemble drain plug in reverse order of disassembly.

3 Tighten screw (2) to a minimum gap of 5/64 inches and maximum gap of 7/64 inches between screw head (7) and drain plug (5). Chain fastener (8) must be free to rotate about screw (2).

4 Spread pin legs (9) to dimensions shown.

5 Install 13 drain plug assemblies.

HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-7. PERISCOPE M45 COVER, DOORS AND SLEEVES

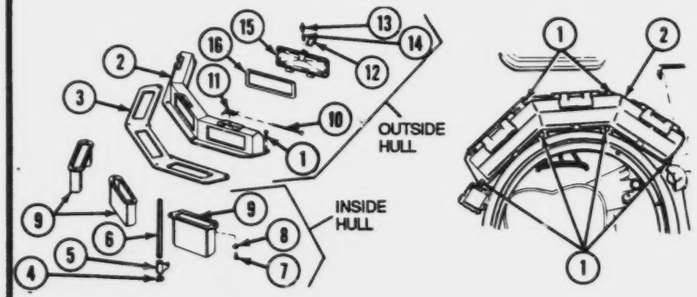
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Material/Parts
Seals (4)
Adhesive (Item 3, App.C)

a. Removal



1 Remove six screws (1), cover (2) and seal (3) from outside hull. Discard seal.

2 Remove six wing nuts (4), six supports (5) and six rods (6) from inside hull.

3 Remove six screws (7), six lockwashers (8) and three periscope sleeves (9) from inside hull.

TA472457

b. Disassembly

1 Remove three pins (10) and three springs (11).

2 Remove three rings (12), three pins (13) and three springs (14).

3 Remove three doors (15) and three seals (16). Discard three seals.

c. Assembly

1 Assemble in reverse order of disassembly.

2 Replace three seals (16), using adhesive (Item 3, App. C).

d. Installation

1 Install in reverse order of removal.

2 Replace seal (3).

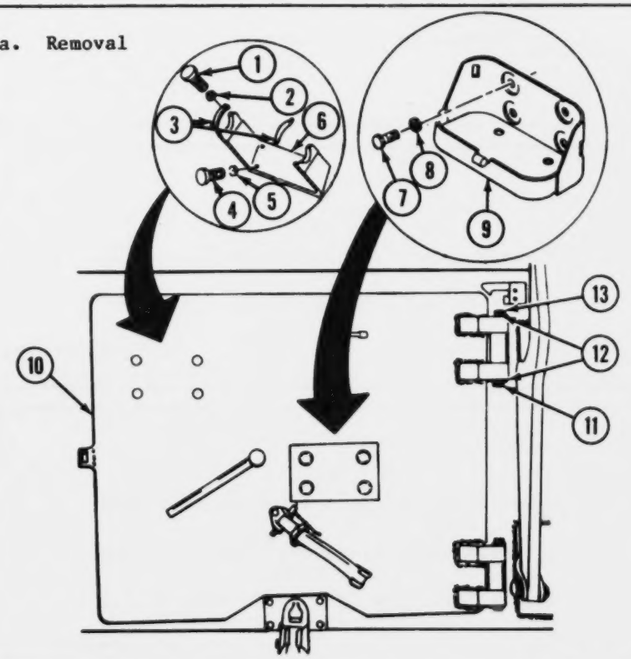
HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-8. HULL REAR DOOR, M13 KIT BRACKET AND DOOR LATCH

This task covers:

a. Removal b. Installation

a. Removal



NOTE

Some M109A3 vehicles have two hull rear doors. Follow removal procedures for the M109A2 vehicle but remove both doors.

1 Remove four screws (1), four lockwashers (2) and two plates (3).

2 Remove four screws (4), four lockwashers (5) and bracket (6).

3 Remove four screws (7), four lockwashers (8) and bracket assembly (9).

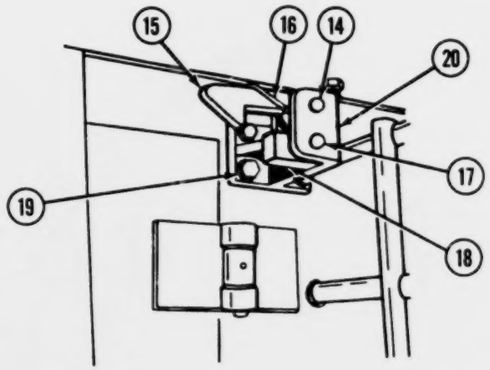
WARNING

Get assistance when removing door. At least four personnel are required to lift it.

4 Open rear door (10) slightly and place support blocks under bottom edge.

5 Remove two nuts (11), four washers (12) and two screws (13).

6 Lift off rear door (10) from hinges. TA472458



7 Remove spring pin (14), latch (15) and spring (16).

8 Remove bumper pin (17) and bumper (18).

9 Remove four screws (19) and bracket (20).

b. Installation

1 Install hull rear door(s) and door latch(s).

2 Install in reverse order of removal.

TA472459

HULL-RELATED COMPONENTS - SECTION II. HATCHES, LATCHES, LOCKS & COVER PLATES - CONTINUED

11-9. HULL REAR DOOR HOLD-OPEN ROD AND HANDLE

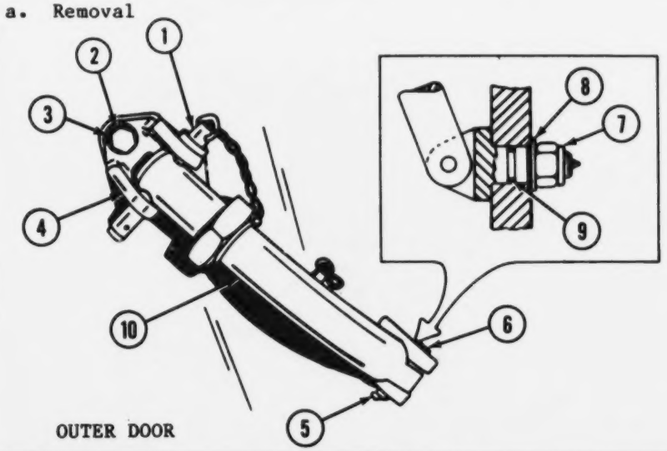
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Preformed packing
Cotter pin

a. Removal

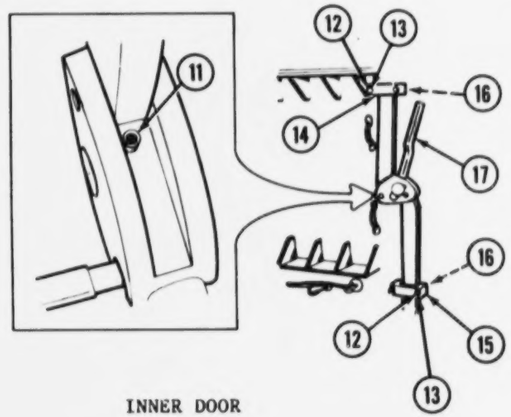


1 Remove pin (1), two screws (2), two washers (3) and bracket (4).

2 Remove cotter pin (5) and headed pin (6). Discard cotter pin.

3 Remove nut (7), flatwasher (8), preformed packing (9) and rod assembly (10). Discard preformed packing.

TA472460



INNER DOOR

4 Remove spring pin (11).

5 Remove four screws (12) and four flatwashers (13), upper slide (14), lower slide (15) and shims (16).

6 Remove inside and outside handle assemblies (17) with components.

b. Installation

1 Install in reverse order of removal.

2 Replace cotter pin (5).

TA472461

HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE

11-10. TUBE TRAVEL LOCK

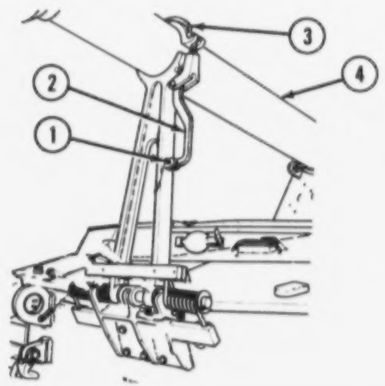
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation and Adjustment

INITIAL SET-UP

Special Tools	Personnel Required	Materials/Parts
Hoist or wrecker	3	Cotter pins (5), Linings (2), Wire rope, Adhesive (Item 55, App. B)

a. Removal



TA472462

NOTE

This removal procedure of the tube travel lock is without removal of the mounting bracket. For removal with the mounting bracket attached begin with step 14.

1 Remove pin assembly (1).

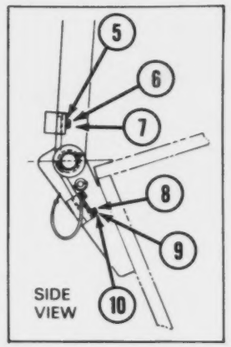
2 Lift handle (2) to unfasten travel lock cap (3).

3 Elevate and traverse cannon tube (4) to clear travel lock.

WARNING

Travel lock cap must be secured to avoid possible injury during removal.

M109A3 ONLY



4 Secure travel lock cap (3). Replace pin assembly (1).

NOTE

Follow steps 5 through 8 for M109A3 vehicles only.

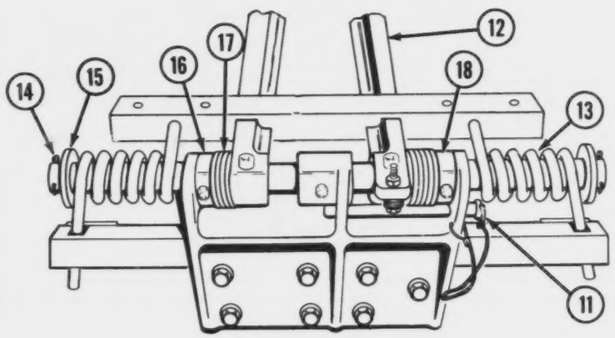
5 Remove retaining bars (5), screws (6) and washers (7) on both sides of travel lock.

6 Remove screws (8), washers (9) and plates (10) on both sides of mounting bracket.

7 Pull pin (11).

WARNING

Be careful when raising or lowering the travel lock and during removal of the counter balance springs. Travel lock is heavy.



8 Move support arm (12) forward to unload springs (13).

9 Remove cotter pin (14) and washer (15) at right mounting lug (16). Discard cotter pin.

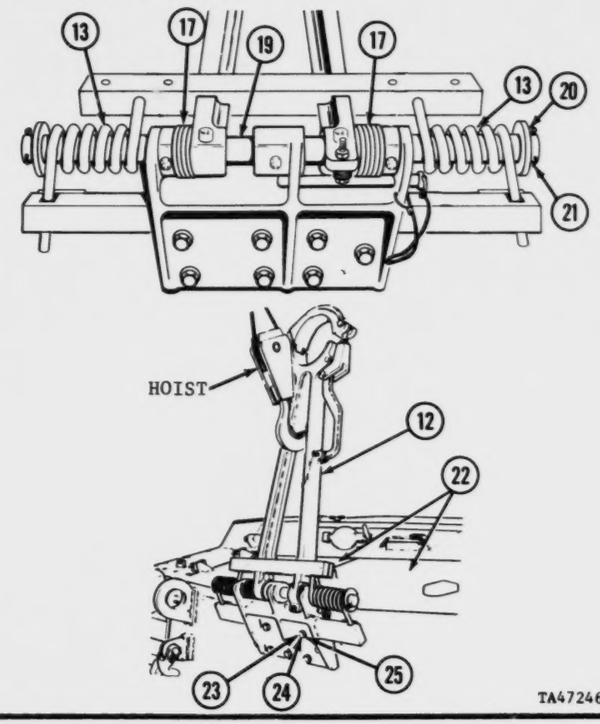
10 Record number of spacer washers (17) between each end of travel lock support arm (12) and right and left lugs (16) and (18).

TA472463

HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE - CONTINUED

11-10. TUBE TRAVEL LOCK - CONTINUED

a. Removal - Continued



TA472464

WARNING

Lock support is heavy. At least two personnel should assist in handling as pin is removed.

11 Remove pin (19) (drive pin from right to left), spacer washers (17), washer (20) and cotter pin (21). Discard cotter pin.

NOTE

Follow step 12 for M109A3 vehicles only.

12 Remove two springs (13).

13 Remove travel lock support arm (12).

NOTE

Steps 14 through 17 are for removal of the travel lock with mounting bracket.

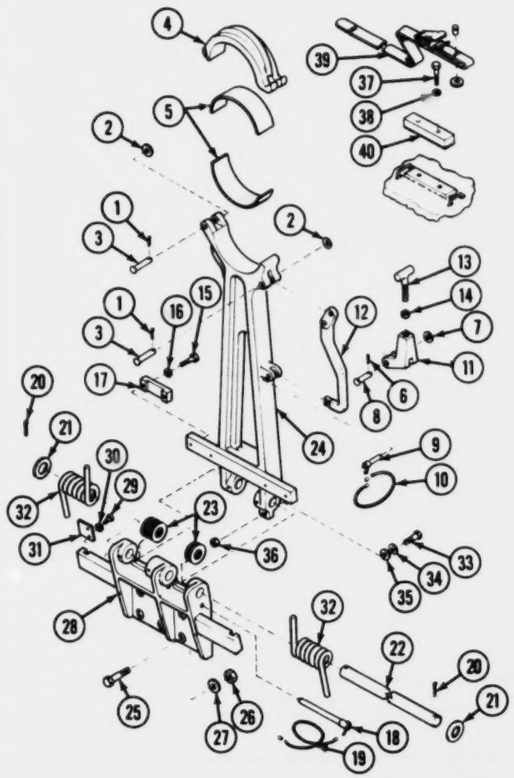
14 Release travel lock support arm (12) from tube. Secure with hoist.

15 Open transmission access doors (22).

16 Remove seven screws (23), seven nuts (24) and seven lockwashers (25).

17 Pull travel lock assembly away from vehicle.

b. Disassembly



WARNING

Gun tube must be out of support before disassembly.

Disassemble M109A2 travel lock items in numerical order.

LEGEND

1. Cotter pin (2) *
2. Flat washer (2)
3. Headed pin (2)
4. Cap
5. Cap lining (2) *
6. Cotter pin *
7. Washer
8. Headed pin
9. Lock pin
10. Wire rope assembly *
11. Clevis
12. Handle
13. Tee
14. Jam nut
15. Screw (4)
16. Washer (4)
17. Torsion spring retainer (2)
18. Lock pin
19. Wire rope assembly *
20. Cotter pin (2) *
21. Flat washer (2)
22. Pin
23. Spacer washers (12) **
24. Support arm
25. Screw (7)
26. Nut (7) ***
27. Flat washer (7) ***
28. Bracket
29. Screw (4)
30. Washer (4)
31. Torsion bar retainer (2)
32. Torsion spring (2)
33. Adjusting screw
34. Washer
35. Washer
36. Nut
37. Screw
38. Lockwasher
39. Strap
40. Bumper

NOTE

If removal procedure was without the removal of the mounting bracket, then items (20), (21), (22) and (23) should already be disassembled.

* Discard item

** Position spacer washers (Item 23) on either side of support arm lugs as required for alinement. Refer to page 11-38 for travel lock adjustment and installation.

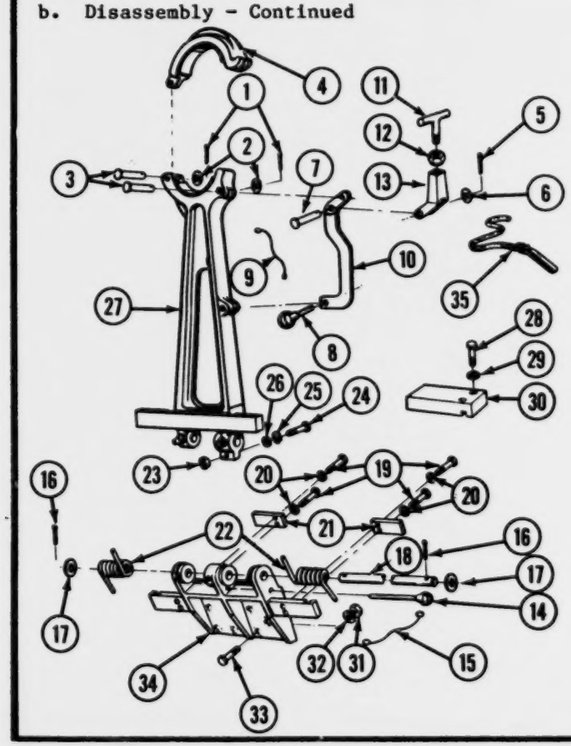
*** Located in powerplant compartment.

TA472465

HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE - CONTINUED

11-10. TUBE TRAVEL LOCK - CONTINUED

b. Disassembly - Continued



Disassemble M109A3 tube travel lock in numerical order.

LEGEND

1.	Cotter pin (2) *	18.	Pin, straight, headless
2.	Flatwasher	19.	Screw, hex head
3.	Headed pin	20.	Flatwasher
4.	Cap (with linings)	21.	Plate
5.	Cotter pin *	22.	Spring
6.	Flatwasher	23.	Nut, hex
7.	Headed pin	24.	Screw, hex head
8.	Lock pin, quick release	25.	Lockwaser
		26.	Flatwasher
9.	Wire rope assembly *	27.	Support, travel lock
10.	Handle	28.	Screw, hex head
11.	Tee bolt	29.	Lockwasher
12.	Jamnut	30.	Bar, retaining
13.	Clevis	31.	Nut, hex head **
14.	Lock pin, quick	32.	Flatwasher **
15.	Wire rope assembly *	33.	Screw, hex head
16.	Cotter pin (2) *	34.	Bracket, travel lock
17.	Flatwasher	35.	Strap

NOTE

If removal procedure was without the removal of the mounting bracket, then items (16) through (22) and (28) through (30) should already be disassembled.

* Discard item
** Located in powerplant

TA472466

c. Assembly

NOTE

Follow steps 1 through 5 for M109A2 vehicles only.

1 Assemble M109A2 tube travel lock in reverse order of disassembly located on page 11-35.

2 Replace discarded items (1), (6), (10), (19) and (20).

3 Apply adhesive (Item 55, App. C) to two cap lining surfaces and install cap linings (5).

4 Torque seven screws (25) 350-370 lb-ft (474.5-501.5 Nm).

5 Apply primer (Item 56, App. C) to all contact surfaces.

NOTE

Follow steps 6 through 10 for M109A3 vehicles only.

6 Assemble M109A3 tube travel lock in reverse order of disassembly located on page 11-36.

7 Replace discarded items (1), (5), (9), (15) and (16).

8 Apply adhesive (Item 55, App. C) to two cap lining surfaces and install cap linings.

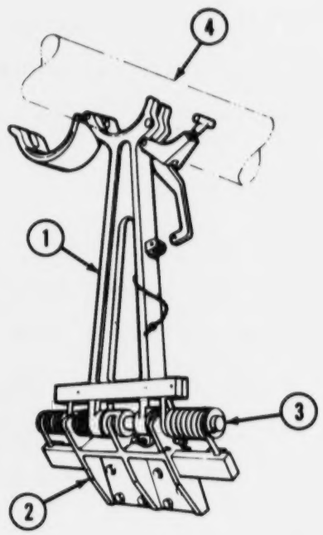
9 Torque seven screws (33) 350-370 lb-ft (474.5-501.5 Nm).

10 Apply primer (Item 56, App. C) to all contact surfaces.

HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE - CONTINUED

11-10. TUBE TRAVEL LOCK - CONTINUED

d. Installation and Adjustment



WARNING

Be careful when raising or lowering the travel lock and during installation of the counterbalance springs. Travel lock is heavy.

1 Traverse turret to forward center of vehicle.

2 Put cab in manual traverse mode and engage traverse lock. Insure that lock is fully engaged by attempting to traverse.

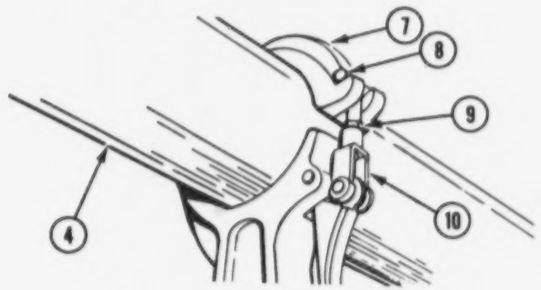
3 Elevate gun to approximately +270 mils.

4 Place support arm (1) in center of bracket (2). Insert pin (3). Make sure support arm is still centered. Do not install spacer washers.

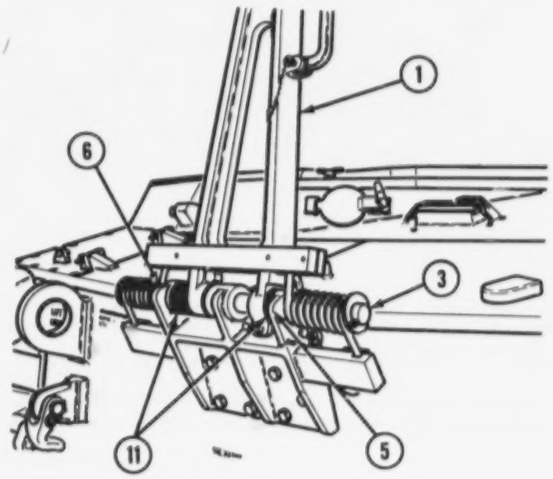
5 Lower gun tube (4) into support arm (1). Slide support arm (1) (left to right) on pin (3) until center of arm is alined with center line of gun tube.

6 Rotate support arm (1) front to back on pin until gun tube (4) lies flat on support arm cap lining surface.

TA472467



7 Close and lock cap (7). Adjust to provide a positive grip on the tube (4) by adjusting tee (8) and jamnut (9) on clevis (10).



8 Install spacer washers (11) as follows:

A. Drive pin (3) from right to left just far enough to install washers on pin between lub (6) and support arm (1).

B. Install spacer washers (11) to fill washer space.

C. Drive pin (3) from left to right just far enough to install washers on pin between between lub (5) and support arm (1).

D. Install spacer washers (11) to fill washer space.

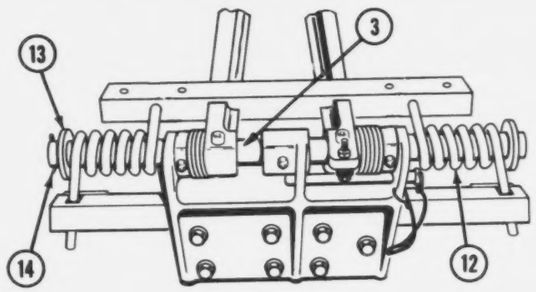
E. Return pin (3) to center position.

TA472468

HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE - CONTINUED

11-10. TUBE TRAVEL LOCK - CONTINUED

d. Installation and Adjustment - Continued

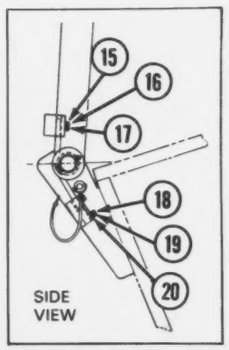


NOTE

Follow Steps 8 through 11 for M109A3 vehicles only.

8 Install springs (12) on pin (3).

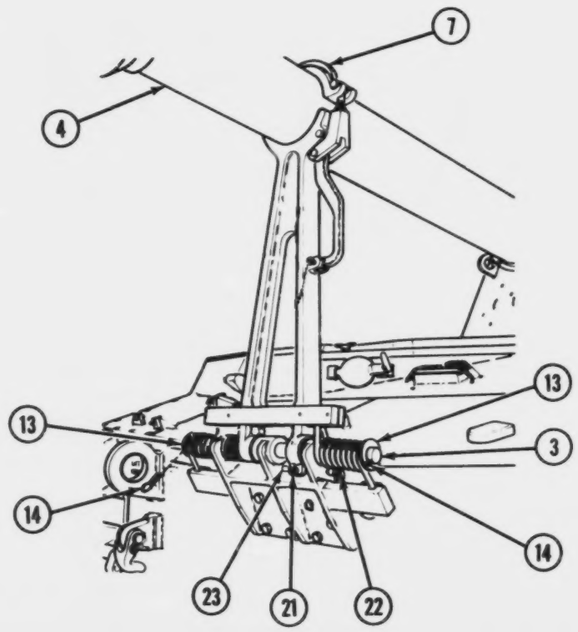
9 Secure pin (3) with washer (13) and cotter pin (14) on each end of pin.



10 Secure springs (12) to both sides of travel lock with retainers (15), washers (16) and screws (17).

11 Secure springs (12) to both sides of mounting bracket with plates (18), screws (19) and washers (20).

TA472469



NOTE

Follow Step 13 for M109A2 vehicles only.

13 Install two flatwashers (13) and two new cotter pins (14) in pin (3).

14 Remove nut (21). Adjust until contact with pin (22).

15 Fill space between head of screw and support arm with washers by adjusting screw (23).

16 Install and tighten nut (21).

17 Adjustment test:

A. Release cap (7).
B. Traverse cannon (4).
C. Return to centerline.
D. Check alinement (ref. p. 11-38).

TA472470

HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE - CONTINUED

11-11. SPADE

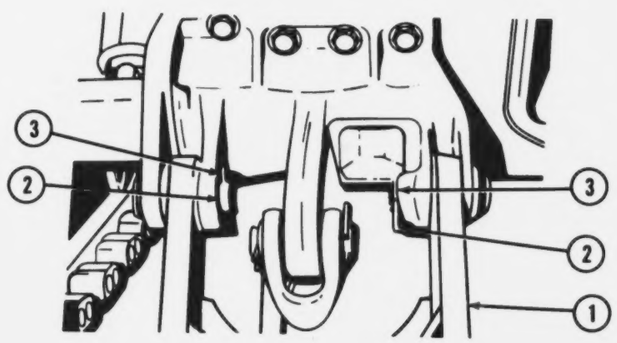
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation e. Adjustment

INITIAL SET-UP

Personnel Required
3

a. Removal



WARNING

Spade is heavy. Use at least 3 personnel to assist in lowering and removing it from hull.

1 Unlatch and lower spade (1) to ground.

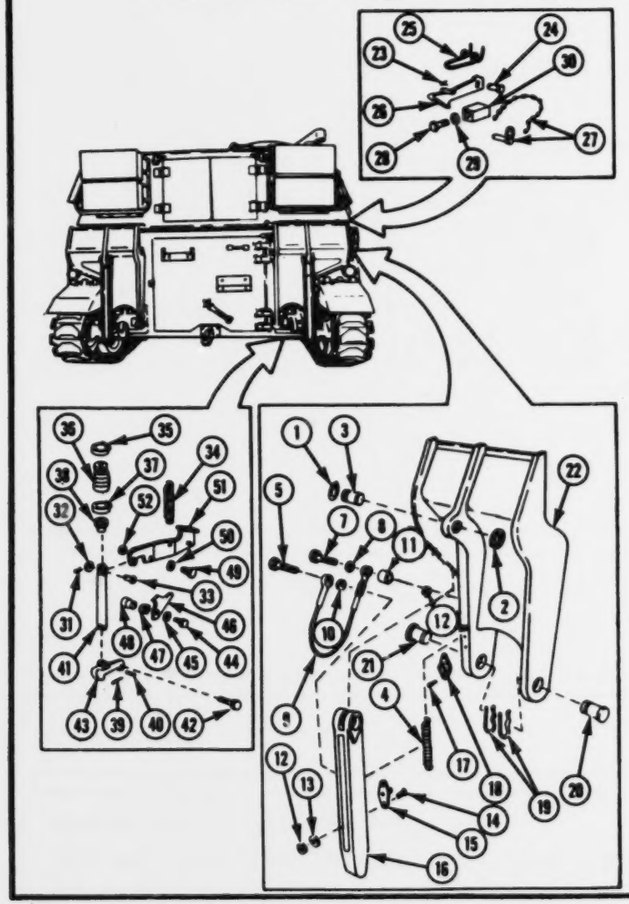
2 Remove two snap rings (2) and two spade pins (3).

3 Remove spade (1).

TA472471

b. Disassembly

Disassemble spade using the illustration as a guide.



LEGEND

1.	Snap ring	27.	Pin assembly
2.	Snap ring	28.	Screw
3.	Pin	29.	Flatwasher
4.	Spring	30.	Bumper
5.	Screw	31.	Cotter pin *
6.	Deleted	32.	Flatwasher
7.	Screw	33.	Pin
8.	Flatwasher	34.	Spring
9.	Cable	35.	Clamp
10.	Flatwasher	36.	Boot
11.	Spacer	37.	Clamp
12.	Nut (3)	38.	Sleeve
13.	Lockwasher (2) *	39.	Cotter pin *
14.	Screw (2)	40.	Pin
15.	Plunger	41.	Shaft
16.	Strut	42.	Screw
17.	Screw (2)	43.	Latch
18.	Socket	44.	Screw
19.	Snap pin (2)	45.	Flatwasher
20.	Pin	46.	Latch
21.	Pin	47.	Spring
22.	Spade	48.	Spacer
23.	Cotter pin *	49.	Screw
24.	Pin	50.	Flatwasher
25.	Spring	51.	Pedal
26.	Latch	52.	Spacer

* Discard item

TA472472

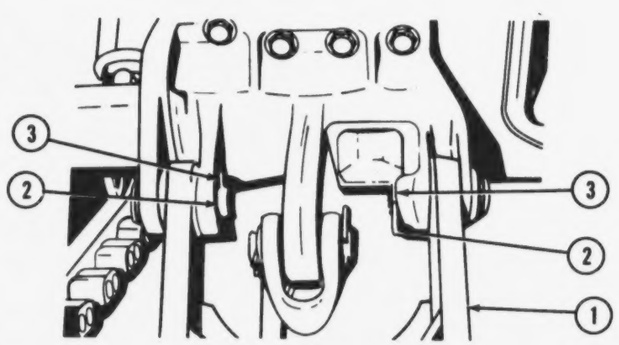
HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE - CONTINUED

11-11. SPADE - CONTINUED

c. Assembly

Assemble in reverse order of disassembly using illustration on page 11-43 as a guide.

d. Installation



WARNING

Spade is heavy. Use at least three personnel to assist in raising and installing it from hull.

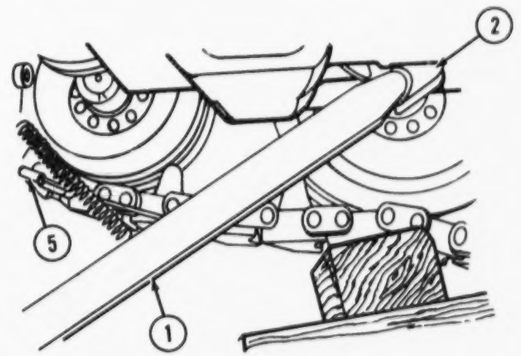
1 Position spade (1) with blade resting on ground and with holes alined to allow spade pins to be installed.

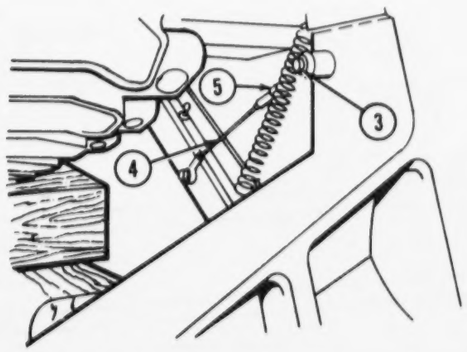
2 Install two spade pins (2) and two snap rings (3).

3 Check adjustment of spade to insure proper operation (ref. p. 11-45). Once adjustment is correct, stow in the up position.

TA472473

e. Adjustment





1 Back-up vehicle over log or other object (at least 18 inches high) to allow full extension of the spade when lowered.

2 Lower spade.

NOTE

When replacing old cable adjuster, do not attempt to adjust new cable to the length of the old cable.

3 Check strut (1) position relative to latch socket (2). Strut should be in latch socket. If strut is not in socket, continue adjustment step 4.

4 Remove screw (3) and cable (4).

5 Loosen jamnut (5) until strut (1) seats in latch socket (2), then tighten.

6 Reconnect screw (3) and cable (4).

NOTE

Spade adjustment should be verified in firing position as soon as practical.

7 Raise and lower spade several times to verify adjustment.

TA472474

HULL-RELATED COMPONENTS - SECTION III. TUBE TRAVEL LOCK, SPADE, FENDERS AND TOWING PINTLE - CONTINUED

11-12. FENDERS

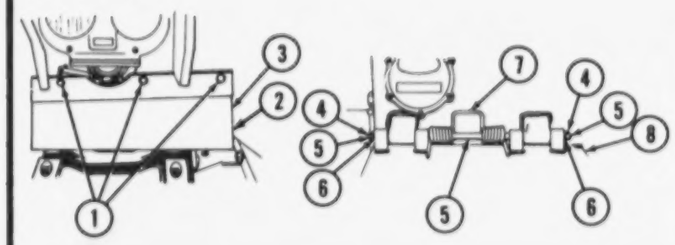
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Cotter pin (2)

a. Removal



1 Remove three screws (1), front fender (2) and retainer (3).

2 Remove two cotter pins (4), straight pin (5), two washers (6), spring (7) and rear fender (8). Discard cotter pins.

b. Installation

1 Install in reverse order of removal.

2 Replace two cotter pins (4).

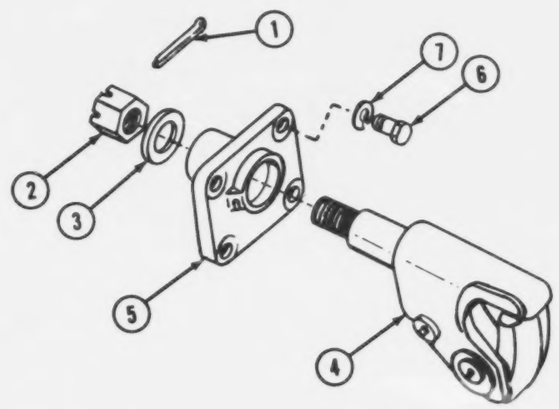
TA472475

11-13. TOWING PINTLE

This task covers:

a. Removal b. Installation

a. Removal



1 Remove cotter pin (1), castle nut (2), flatwasher (3) and pintle (4).

2 Remove four screws (6), four lockwashers (7) and bracket (5).

b. Installation

Install in reverse order of removal.

TA472476

HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER

11-14. BILGE PUMP

This task covers:

a. Removal b. Installation

a. Removal

NOTE

- Powerplant is removed for illustation purposes only.
- If powerplant has been removed, only perform steps 4 through 8 to remove bilge pump.

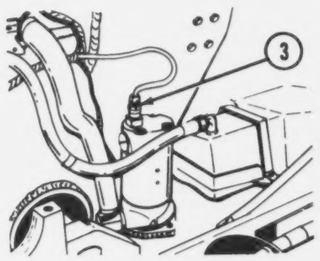
1 Open air intake grille and right transmission access door (ref. p. 4-8 and 4-10).

2 Remove front slope plate (ref. p. 4-10).

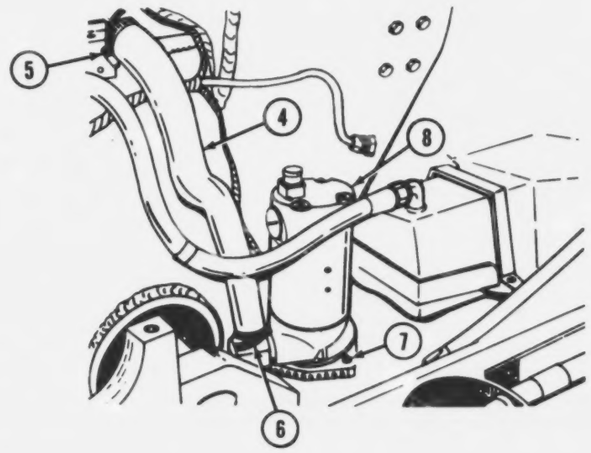
3 Drain engine coolant system (ref. TM 9-2350-311-10).

4 Remove two hose clamps (2) and radiator hose (1).

TA472477



5 Disconnect electrical connector (3).



NOTE

Powerplant is removed for illustration purposes only.

6 Remove two clamps (5) and (6) and hose (4).

7 Remove three mount screws (7).

8 Remove bilge pump (8).

b. Installation

Install in reverse order of removal.

TA472478

HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER - CONTINUED

11-15. PERSONNEL HEATER

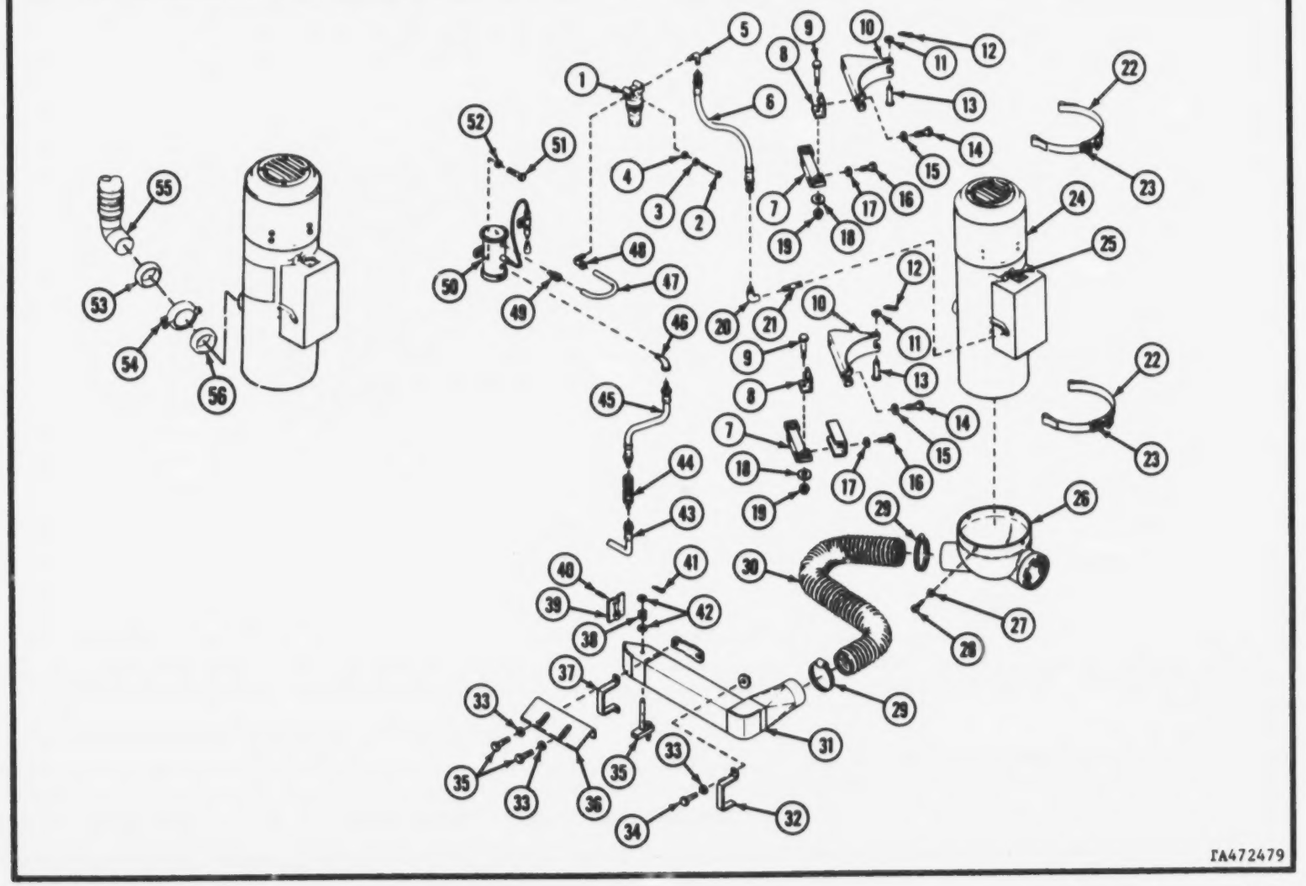
This task covers:

a. Removal b. Installation

LEGEND

1. Fuel filter
2. Screw (2)
3. Lockwasher (2)
4. Flatwasher (2)
5. Elbow
6. Fuel filter to heater hose
7. Resilient mount (2)
8. Bracket angle (4)
9. Screw (4)
10. Bracket (2)
11. Flatwasher (2)
12. Cotter pin (4)
13. Pin (4)
14. Screw (4)
15. Flatwasher (2)
16. Screw (4)
17. Flatwasher (4)
18. Flatwasher (4)
19. Nut (4)
20. Elbow
21. Nipple
22. Clamp
23. Nut (2)
24. Personnel heater
25. Electrical connector
26. Lower duct
27. Lockwasher (4)
28. Screw (4)
29. Clamp (2)
30. Outlet hose
31. Outlet duct
32. Bracket
33. Flatwasher
34. Screw
35. Outlet duct valve handle
36. Outlet duct guard
37. Bracket
38. Spring
39. Outlet duct valve
40. Pin (2)
41. Cotter pin
42. Flatwashers (2)
43. Bulkhead to coupler hose
44. Coupler
45. Coupler to fuel pump hose
46. Elbow
47. Fuel pump to filter hose
48. Elbow
49. Adapter
50. Fuel pump
51. Screw (2)
52. Lockwashers (2)
53. Sleeve
54. Clamp
55. Exhaust tube
56. Flange

PERSONNEL HEATER MOUNTING CLAMP, SADDLE, DUCTS, HOSES, TUBES, AND DEFLECTOR



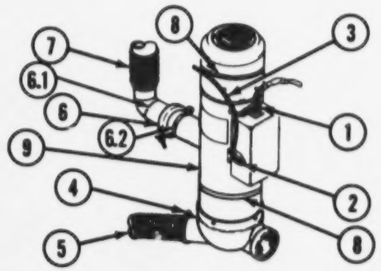
HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER - CONTINUED

11-15. PERSONNEL HEATER - CONTINUED

a. Removal

WARNING

Do not smoke or use open flame inside of or within 50 feet of vehicle during heater removal, installation or repair. The heater may retain fuel which, if spilled, could explode.



1 Disconnect electrical connector (1).

2 Unscrew nut (2) and unscrew and remove fuel line (3).

3 Loosen clamp (4) and remove outlet hose (5).

4 Remove clamp (6), sleeve (6.1) and flange (6.2) from exhaust tube (7).

5 Remove two clamps (8) which secure personnel heater (9).

NOTE

For M109A3 personnel heaters, a clamp at rear of heater also may have to be removed in order to remove heater.

6 Remove personnel heater (9).

TA472480

b. Installation

WARNING

Do not smoke or use open flame inside of or within 50 feet of vehicle during heater removal, installation or repair. The heater may retain fuel which, if spilled, could explode.

NOTE

For M109A3 personnel heaters, a clamp at rear of heater also may have to be installed in order to install heater.

1 Install two clamps (8) to secure personnel heater (9).

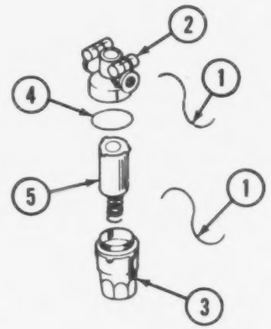
2 Install flange (6.2), clamp (6) and sleeve (6.1) to connect exhaust tube (7).

3 Install outlet hose (5) and tighten clamp (4). Torque screw to 90-95 lb-in (10.1-10.7 Nm).

4 Connect fuel line (3) and install nut (2).

5 Connect electrical connector (1).

b. Disassembly



1 Remove lockwires (1).

2 Unscrew filter head (2) from filter bowl (3).

3 Remove preformed packing (4) and filter element assembly (5). Discard preformed packing.

c. Assembly

1 Assemble in reverse order of removal.

2 Replace preformed packing (4).

3 Replace lockwire (1).

d. Installation

Install in reverse order of removal.

TA472482

HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER - CONTINUED

11-17. PERSONNEL HEATER EXHAUST TUBE

This task covers:

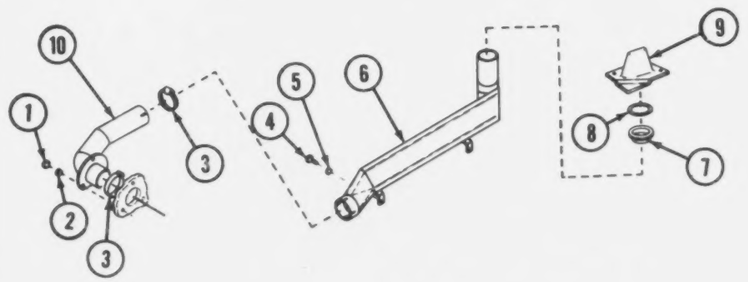
a. Removal/Disassembly b. Assembly/Installation

INITIAL SET-UP

Materials/Parts
Washer (special), Preformed packing

Tools
Automotive Maintenance Common No. 2 Tool Kit
SC 4910-95-CL-A72

a. Removal/Disassembly



1 Remove three nuts (1) and three lockwashers (2) at bulkhead.

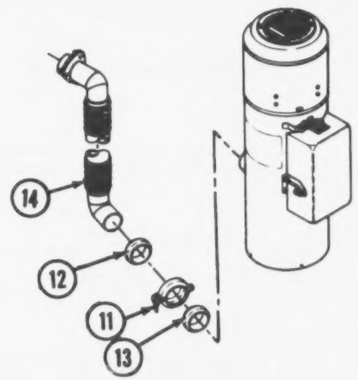
2 Loosen nuts and slide two clamps (3) onto tube (10).

3 Remove two screws (4) and two lockwashers (5) at bulkhead.

4 Pull tube (6), special washer (7) and preformed packing (8) away from exhaust deflector (9). Discard special washer (7) and preformed packing (8).

5 Remove tube (10), two clamps (3) and tube (6) from vehicle and separate.

TA472483



6 Remove clamp (11), sleeve (12) and flange (13).

7 Remove flexible exhaust tube (14).

b. Assembly/Installation

1 Assemble and install in reverse order of removal/disassembly.

2 Replace special washer (7).

3 Replace preformed packing (8).

4 Torque clamp (11) screw to 90-95 lb-in (10.1-10.7 Nm).

TA472484

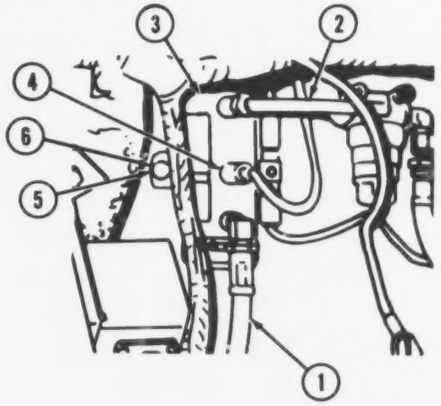
HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER - CONTINUED

11-18. PERSONNEL HEATER FUEL PUMP

This task covers:

a. Removal b. Installation

a. Removal



1 Disconnect fuel input hose (1) and fuel pump to fuel filter hose (2) at fuel pump (3).

2 Disconnect electrical connector (4).

3 Remove two screws (5) and two lockwashers (6).

4 Remove fuel pump (3).

b. Installation

Install in reverse order of removal.

TA472485

11-19. PERSONNEL AIR VENTILATION SYSTEM

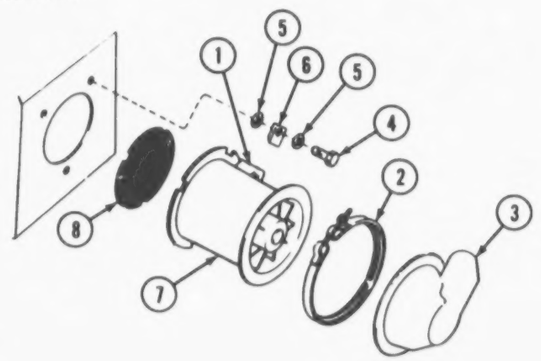
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Drycleaning solvent (Item 16, App C).

a. Removal



1 Turn master switch off and disconnect electrical connector at electrical connector receptacle (1).

2 Remove clamp (2) and elbow (3).

3 Remove three screws (4), six flatwashers (5) and three plates (6).

4 Remove fan assembly (7) and screen (8).

5 Clean screen (8) with drycleaning solvent (Item 18, App. C), or water and nonsudsing detergent.

b. Installation

Install in reverse order of removal.

TA472486

HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER - CONTINUED

11-20. FIXED FIRE EXTINGUISHER SYSTEMS

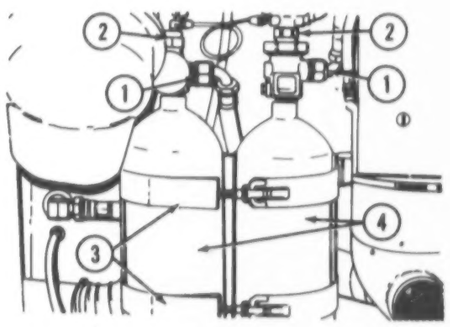
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation e. Safety wiring

INITIAL SET-UP

Materials/Parts
Safety wire

a. Removal



WARNING

Carbon dioxide cylinders must not be dropped, struck, or subject to temperatures above 140°F (60°C).

NOTE

The illustration is of the late models M109A3 and the M109A2. Removal is the same for earlier models M109A3, though the configuration will differ.

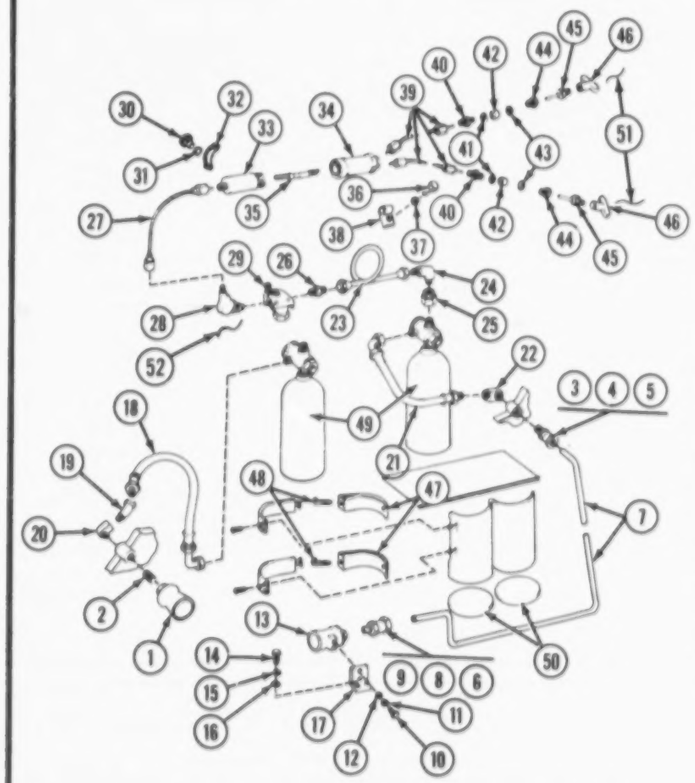
1 Disconnect two hose connectors (1).

2 Disconnect two head connectors (2).

3 Remove two clamps (3) and remove two carbon dioxide bottles (4).

TA472487

b. Disassembly



Disassemble late model M109A3 and M109A2 fixed fire extinguisher systems as required using illustration as a guide.

LEGEND

1. Nozzle
2. Nipple
3. Nut
4. Sleeve
5. Connector
6. Nut
7. Tube
8. Sleeve
9. Connector
10. Screw (2)
11. Lockwasher (2)
12. Flatwasher (2)
13. Nozzle
14. Screw (2)
15. Lockwasher (2)
16. Flatwasher (2)
17. Bracket
18. Hose assembly
19. Elbow
20. Elbow
21. Hose assembly
22. Elbow
23. Tube assembly
24. Elbow
25. Head
26. Connector
27. Cable assembly
28. Pulley
29. Valve control
30. Screw (2)
31. Flatwasher (3)
32. Strap
33. Pull mechanism
34. Pull mechanism
35. Clamp
36. Screw (2)
37. Flatwasher (2)
38. Clip (2)
39. Flexible conduit
40. Conduit connectors
41. Washer (2)
42. Conduit packing (2)
43. Washer (2)
44. Conduit nut (2)
45. Conduit-to-handle fastener (2)
46. Pull handle (2)
47. Retaining strap (2)
48. Retaining strap catch (2)
49. CO_2 cylinder assembly (2)
50. Pad (2)
51. Safety wire (2)
52. Seal (disassembly only)

TA472488

HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER - CONTINUED

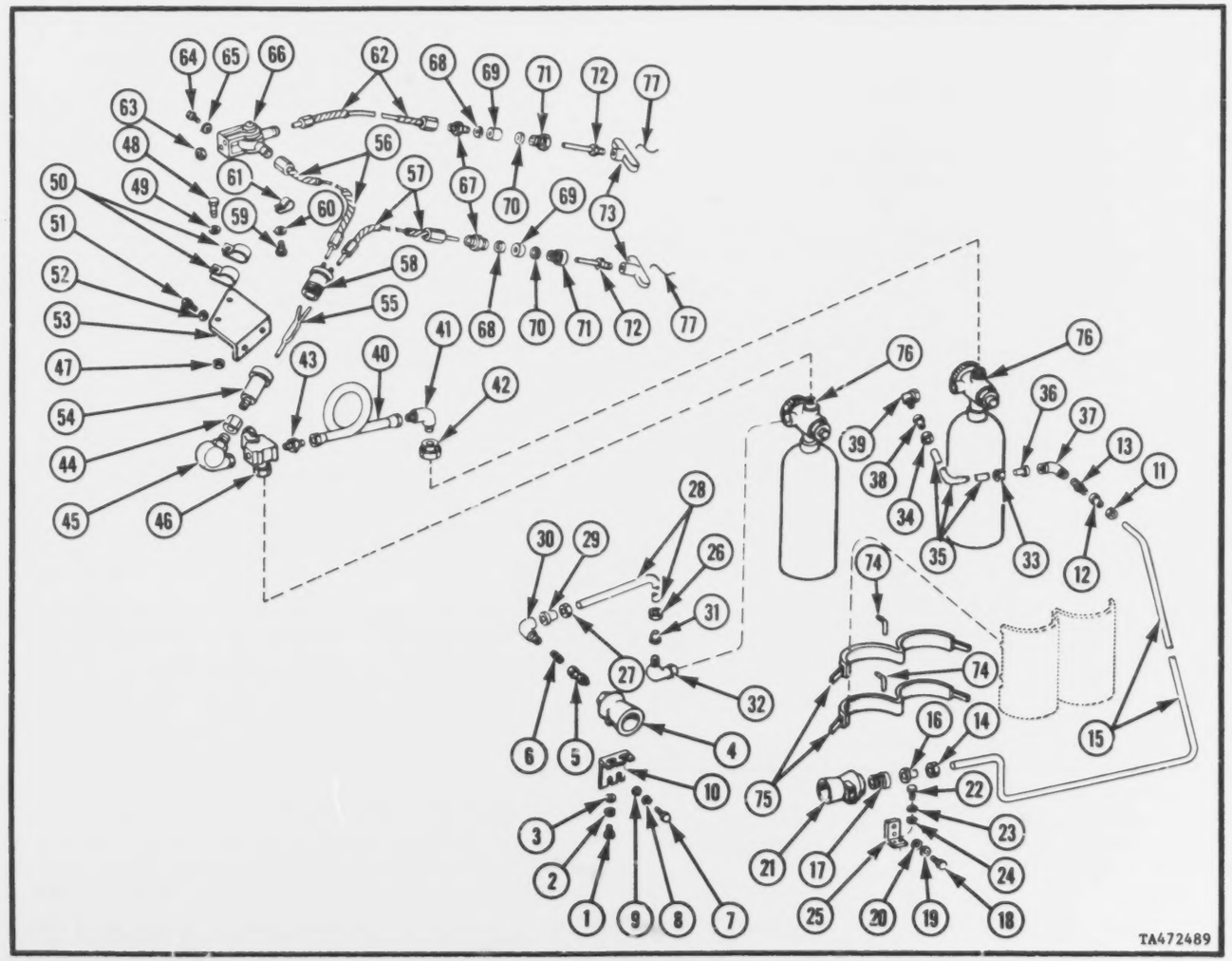
11-20. FIXED FIRE EXTINGUISHER SYSTEMS - CONTINUED

b. Disassembly - Continued

Disassemble earlier model M109A3 fixed fire extinguisher as required using illustration as a guide.

LEGEND

1. Nozzle screw (2)
2. Lockwasher (2)
3. Flatwasher (2)
4. Nozzle
5. Nozzle adapter
6. Nipple
7. Bracket screw (2)
8. Lockwasher (2)
9. Flatwasher (2)
10. Nozzle bracket
11. Tube nut
12. Tube sleeve
13. Adapter
14. Tube nut
15. Tube
16. Tube sleeve
17. Connector
18. Nozzle screw (2)
19. Lockwasher (2)
20. Flatwasher (2)
21. Nozzle
22. Bracket screw (2)
23. Lockwasher (2)
24. Flatwasher
25. Nozzle bracket
26. Tube nut
27. Tube nut
28. Tube
29. Tube sleeve
30. Elbow
31. Tube sleeve
32. Elbow assembly
33. Tube nut
34. Tube nut
35. Elbow
36. Tube sleeve
37. Elbow
38. Tube sleeve
39. Elbow assembly
40. Tube assembly
41. Elbow
42. Head
43. Connector
44. Pulley mounting nut
45. Angle pulley
46. Control valve
47. Support mounting nut (2)
48. Support screw (2)
49. Flatwasher (2)
50. Pull mechanism clamp (2)
51. Support screw (2)
52. Flatwasher
53. Pull mechanism support
54. Pull mechanism
55. Conduit clamp
56. Flexible conduit
57. Flexible conduit
58. Pull mechanism
59. Clamp screw (5)
60. Flat washer (5)
61. Conduit clamp (5)
62. Flexible conduit
63. Pulley mounting nut
64. Pulley mounting screw (4)
65. Lockwasher (4)
66. 90-degree pulley
67. Conduit connector (2)
68. Washer (2)
69. Conduit packing (2)
70. Washer (2)
71. Conduit nut (2)
72. Conduit-to-handle fastener (2)
73. Pull handle (2)
74. Support lock pin (2)
75. Cylinder support (2)
76. CO_2 cylinder (2)
77. Safety wire (2)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TA472489

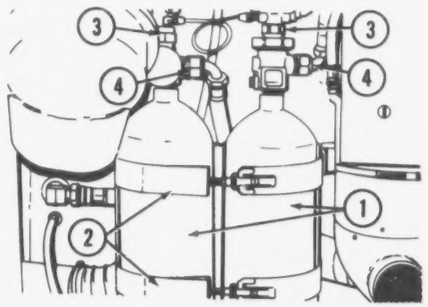
HULL-RELATED COMPONENTS - SECTION IV. BILGE PUMP, PERSONNEL HEATER, PERSONNEL AIR VENTILATION SYSTEM AND FIXED FIRE EXTINGUISHER - CONTINUED

11-20. FIXED FIRE EXTINGUISHER SYSTEMS - CONTINUED

c. Assembly

Assemble in reverse order of disassembly.

d. Installation



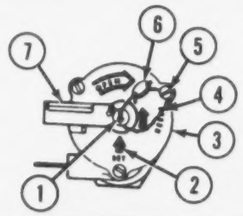
1 Install two carbon dioxide bottles (1).

2 Install two clamps (2).

3 Connect two head connectors (3).

4 Connect two hose connectors (4).

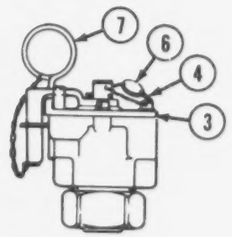
e. Safety Wiring

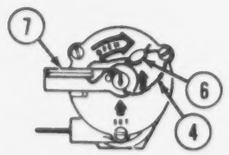


1 Aline arrow on camshaft (1) with set arrow (2) on control plate (3) for safety wiring of control valves.

2 Start safety wiring at hole in mounting screw (5).

TA472490





3 Go to hole in camshaft and then to hole in lead seal (6).

NOTE

If lockpin is not equipped with safety clamp, follow steps 6 and 7.

4 Draw safety wire (4) tight.

5 Crimp lead seal (6) securely on both ends at safety wire (4).

6 Feed safety wire (4) through lockpin (7).

7 Repeat steps 4 and 5.

TA472491

CHAPTER 11.1
NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) PROTECTION EQUIPMENT

GENERAL

This chapter illustrates and defines procedures for removal, disassembly, assembly and installation of M109A4 Ventilated Face Piece System (VFPS).

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NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) PROTECTION EQUIPMENT

11-21 AIR PURIFIER

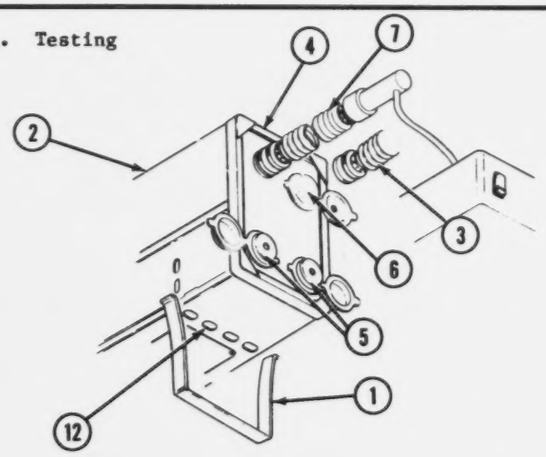
This task covers:

a. Testing b. Removal c. Disassembly d. Assembly e. Installation

INITIAL SET-UP

Special tools
Airflow tester (Item 51, App. B)

a. Testing



NOTE

For additional information refer to TM 3-6680-316-10.

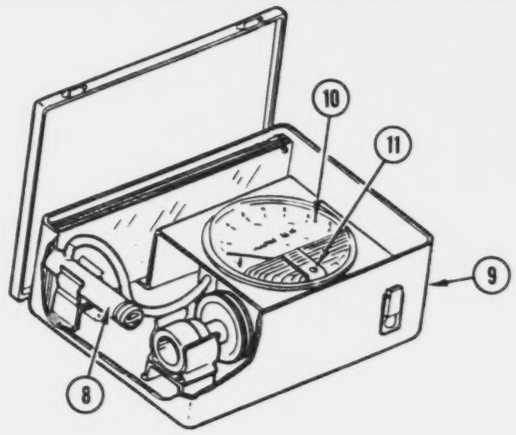
1 Remove spring clip (1) from housing (2).

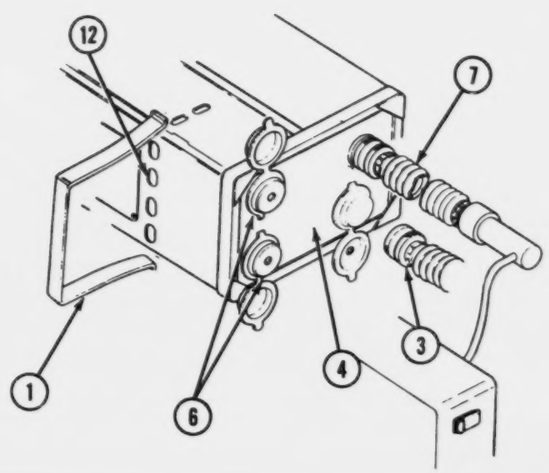
2 Disconnect hose (3) from air purifier manifold (4).

3 Ensure that two purifier openings are covered with airflow caps (5) having small holes.

4 Cover other opening with solid airflow cap (6).

5 Disconnect attached hose (7) at driver's heater.





6 Remove calibrated orifice (8) from the tester case (9).

7 Zero magnehelic gage (10) using adjustment screw (11) after positioning gage where it can be easily read.

8 Attach hose (7) to calibrated orifice (8).

9 Turn on MASTER power switch.

10 Turn on NBC power switch.

11 Read gage (10). If air flow is within 2.0 to 4.7 inches of water, it is acceptable. Proceed to step 13. If airflow is not acceptable, proceed to step 12.

12 Adjust air flow by inserting a screwdriver through left center slot (12) and into adjuster. Turn counterclockwise to increase and clockwise to decrease air flow.

13 Turn off NBC power switch.

14 Turn off MASTER power switch.

15 Remove calibrated orifice (8) from hose (7) and return to tester case (9).

16 Connect hose (7) to driver's heater.

17 Connect hose (3) to air purifier manifold (4).

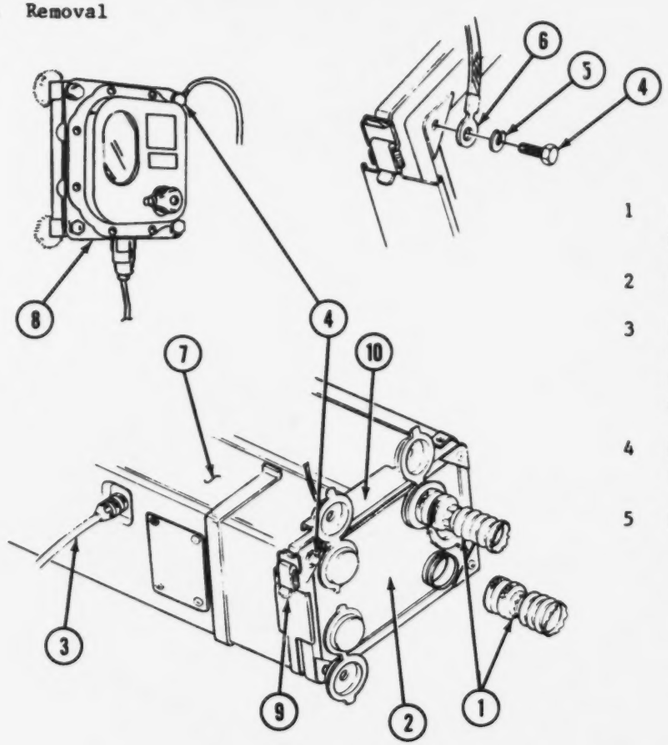
18 Remove two caps with holes on them and install two solid caps (6) on remaining two purifier manifold openings.

19 Install spring clip (1).

NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) PROTECTION EQUIPMENT - CONTINUED

11-21. AIR PURIFIER - CONTINUED

b. Removal



1 Disconnect two hoses (1) from air purifier manifold (2).

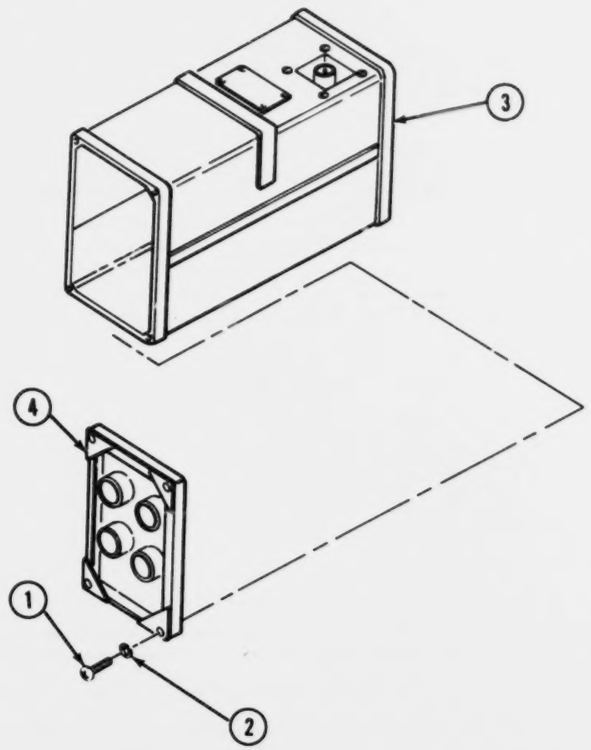
2 Disconnect electrical connector (3).

3 Remove two screws (4) and two lockwashers (5) to remove ground lead (6) from air purifier (7) and dome light (8). Reinstall lockwashers and screws.

4 Release strap (9) on air purifier bracket (10).

5 Remove air purifier (7) from bracket (10).

c. Disassembly



WARNING

To prevent possible chemical or biological agent casualties, contaminated gas and particulate filters must be removed and disposed of only by adequately trained personnel. The unit commander or senior officer in charge of maintenance personnel assigned to remove and dispose of contaminated gas filters must prescribe necessary protective clothing (TM 10-277) to be worn during this operation. The officer must also prescribe necessary safety measures, including decontamination, that must be performed before new gas filters are installed in housing assembly (FM 3-5).

NOTE

If any part of the air purifier is damaged, replace immediately.

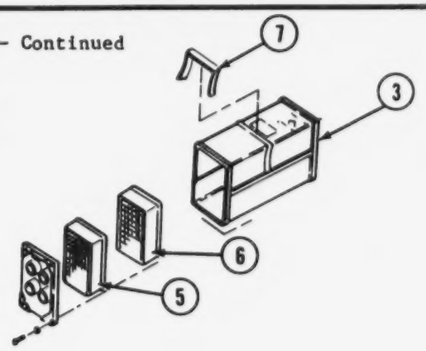
1 Remove four screws (1) and four lockwashers (2) from housing (3).

2 Remove manifold (4).

NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) PROTECTION EQUIPMENT - CONTINUED

11-21. AIR PURIFIER - CONTINUED

c. Disassembly - Continued



CAUTION

Do not allow moisture to come into contact with filter material.

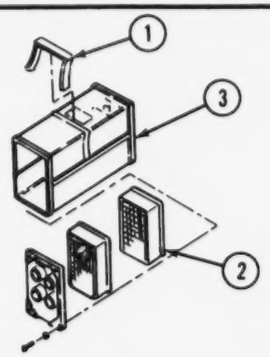
3 Tilt housing (3) and remove gas filter (5) and particulate filter (6).

NOTE

If filters are to be reused, mark arrow on side showing direction of air flow.

4 Remove spring clip (7).

d. Assembly

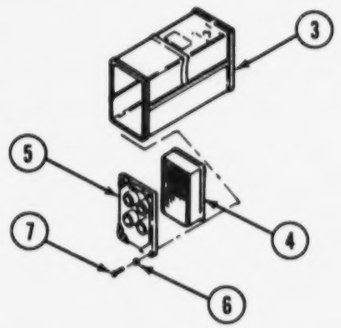


NOTE

Make sure filter rests against bulkhead inside housing.

1 Install spring clip (1).

2 Install particulate filter (2) in housing (3) so air will flow through it in direction marked on filter housing.



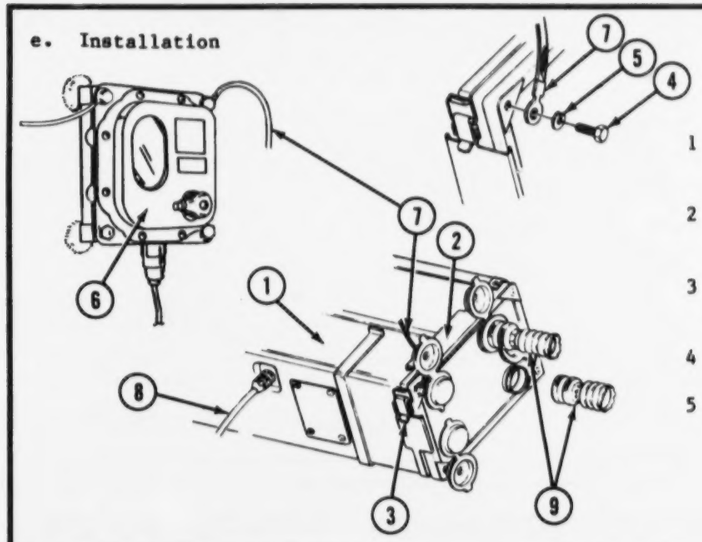
NOTE

Make sure felt gasket side of gas filter is toward manifold assembly end of purifier.

3 Install gas filter (4) in housing (3) so it rests on gasket of particulate filter (2) surface.

4 Install manifold (5) in housing (3) with four lockwashers (6) and four screws (7).

e. Installation



1 Install air purifier (1) in bracket (2) and secure with strap (3).

2 Remove two screws (4) and two lockwashers (5) from air purifier (1) and dome light (6).

3 Install ground lead (7) using two lockwashers (5) and two screws (4).

4 Connect electrical connector (8).

5 Connect two hoses (9).

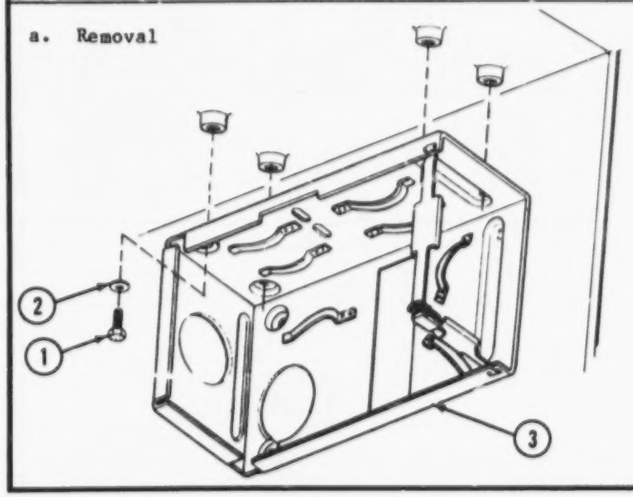
NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) PROTECTION EQUIPMENT - CONTINUED

11-22. AIR PURIFIER BRACKET

This task covers:

a. Removal b. Installation

a. Removal



1 Remove air purifier (ref. p. 11-70).

2 Remove four screws (1), four lockwashers (2) and air purifier bracket (3).

b. Installation

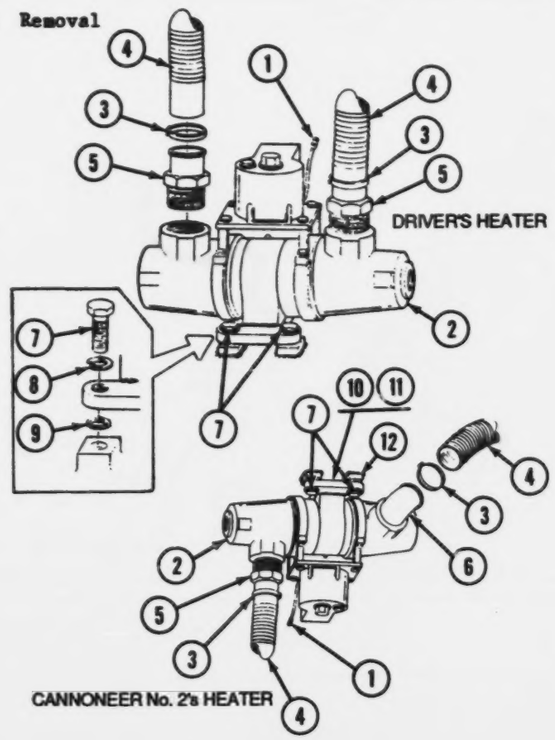
Install in reverse order of removal.

11-23. HEATER

This task covers:

a. Removal b. Installation

a. Removal



NOTE

The following procedure applies to both the driver's and cannoneer No. 2's heater.

Heaters come in various designs. The following procedure applies to all of these designs although the actual heater may differ in appearance from those illustrated.

1 Disconnect electrical connector wire 439B (1) of driver's heater (2) or wire 439C (1) of cannoneer No. 2's heater (2).

2 Loosen two clamps (3). Slide clamps (3) back over two hoses (4).

3 Pull two hoses (4) free from heater (2).

NOTE

Heater at cannoneer No. 2's station has one elbow and one adapter. Heater at driver's station has two adapters.

4 Remove two adapters (5) or adapter (5) and elbow (6) as required.

5 Remove four screws (7), four lockwashers (8) and four external tooth lockwashers (9).

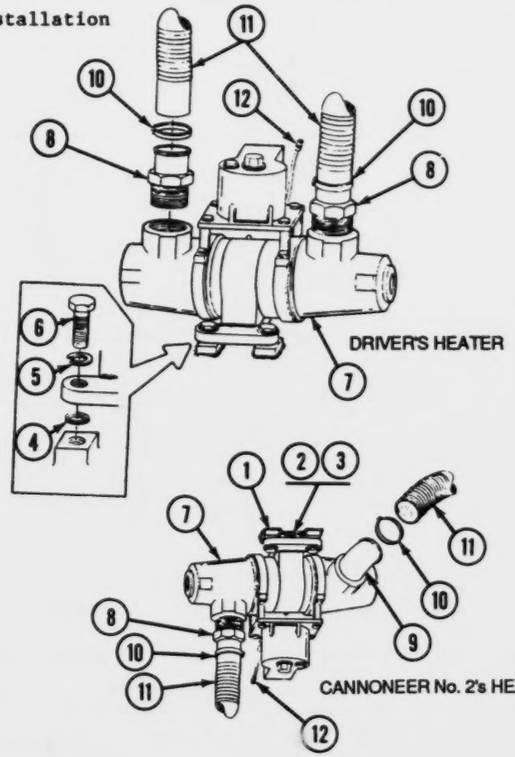
6 Remove heater (2).

7 For cannoneer No. 2's heater remove two screws (10), two external tooth lockwashers (11) and bracket (12).

NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) PROTECTION EQUIPMENT - CONTINUED

11-23. HEATER - CONTINUED

b. Installation



NOTE

- The following procedure applies to both the driver's and cannoneer No. 2's heater.
- Some new heaters may require installation of a mounting plate kit to allow the control knob to be seen. The instructions to install the kit are included with the heater.
- External tooth lockwashers are to be installed between mounting blocks or bracket and heaters.

1 Install bracket (1), two external tooth lockwashers (2) and two screws (3).

2 Install four external tooth lockwashers (4), four lockwashers (5), four screws (6) and heater (7).

NOTE

Heater at cannoneer No. 2's station has one elbow and one adapter. Heater at driver's station has two adapters.

3 Install two adapters (8) or adapter (8) and elbow (9) as required.

4 Install two clamps (10) and two hoses (11) over two adapters (8) or adapter (8) and elbow (9) as required. Tighten clamps (10).

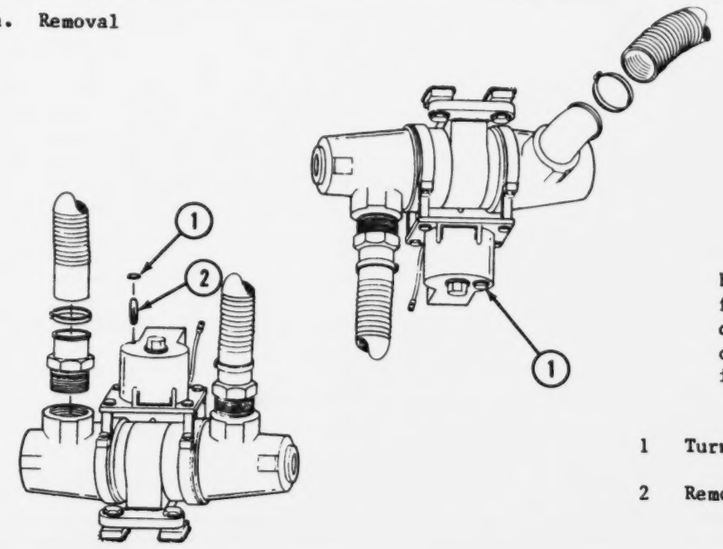
5 Connect electrical connector wire 439B (12) at driver's heater (7) or wire 439C (12) at cannoneer No. 2's heater (7).

11-24. HEATER LAMP

This task covers:

a. Removal b. Installation

a. Removal



WARNING

Be certain MASTER switch is OFF when working on hull electrical system to avoid electrical shocks and burns.

NOTE

Heaters come in various designs. The following procedure applies to all of these designs although the actual heater may differ in appearance from those illustrated.

1 Turn lens (1) counterclockwise and remove.

2 Remove lamp (2) from heater.

b. Installation

Install in reverse order of removal.

NUCLEAR, BIOLOGICAL AND CHEMICAL (NBC) PROTECTION EQUIPMENT - CONTINUED

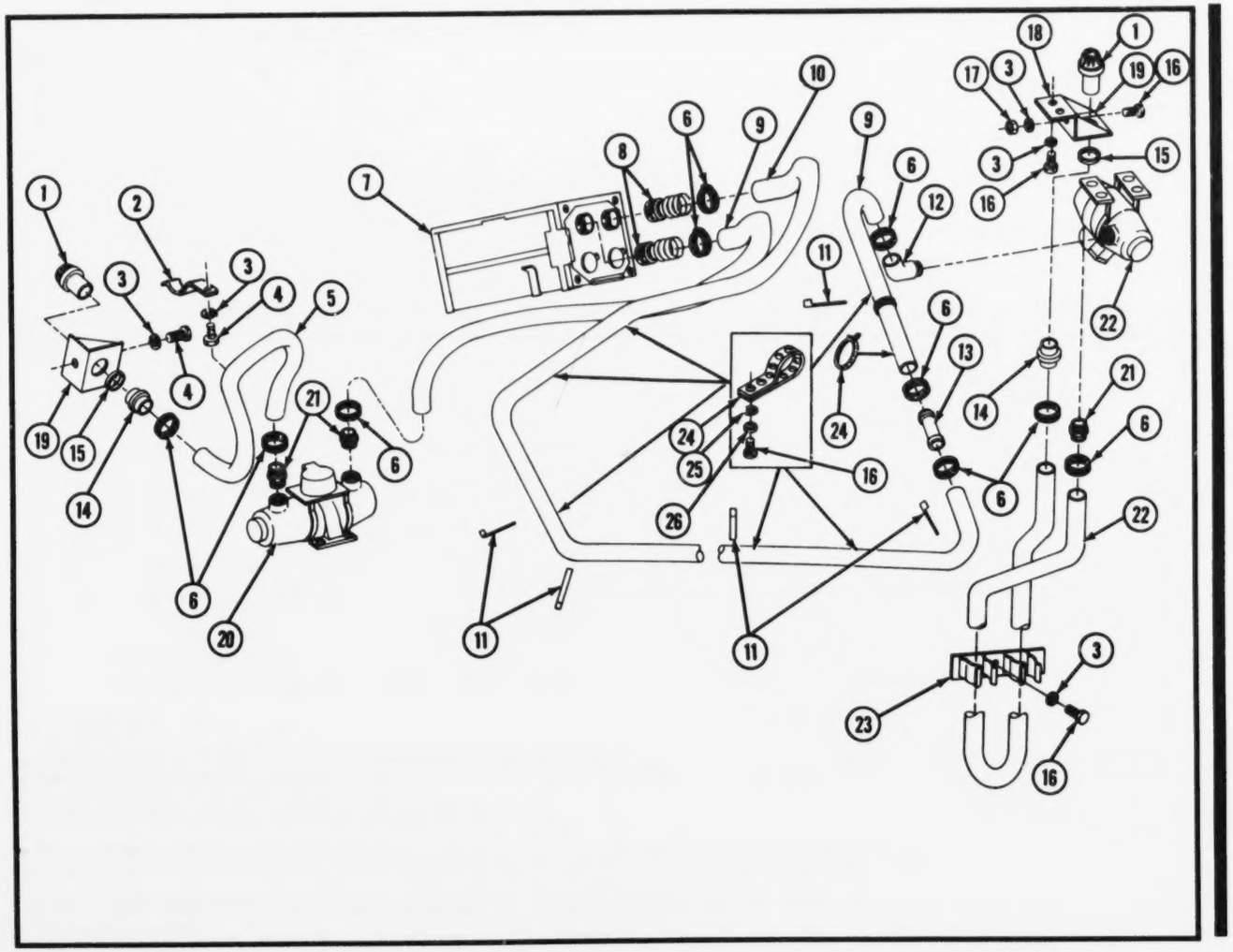
11-25. HOSES AND FITTINGS

This task covers:

a. Removal b. Inspection c. Installation

Legend:

1 Connector (2) (ref. p. 11-81)
2 Clip
3 Lockwashwer (6)
4 Screw (2)
5 Hose
6 Clamp (10)
7 Air Purifier (ref. p. 11-68)
8 Coupling (2)
9 Hose (2)
10 Hose
11 Strap (6)
12 Elbow
13 Tube
14 Coupling (2)
15 Ring (2)
16 Screw (12)
17 Nut
18 Bracket
19 Bracket (2)
20 Heater (2) (ref. p. 11-75)
21 Adapter (3)
22 Hose
23 Clip
24 Strap (6)
25 Washer (6)
26 Washer (6)


1
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NUCLEAR, BIOLOGICAL, AND CHEMICAL (NBC) PROTECTION EQUIPMENT - CONTINUED

11-25. HOSES AND FITTINGS - CONTINUED

a. Removal

Remove clips, straps, clamps and hoses as required. Use illustration on page 11-79 as a reference guide.

b. Inspection

1 Inspect hose clamps and couplings for damage or wear.

2 Inspect hoses for wear, cracks and dry rot.

3 Replace component if necessary.

c. Installation

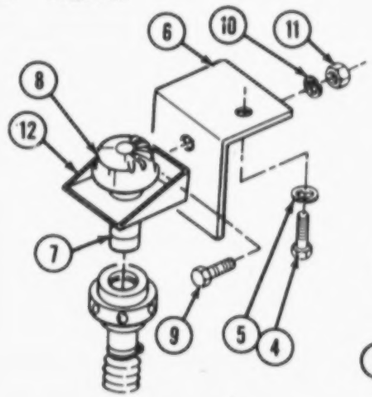
Install in reverse order of removal. Use illustration on page 11-79 as a reference guide.

11-26. AIR OUTLET ORIFICE CONNECTOR

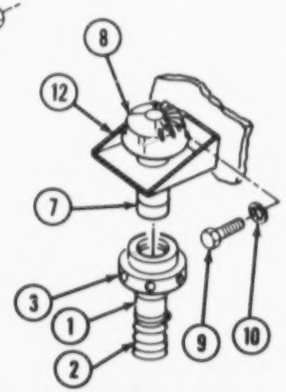
This task covers:

a. Removal b. Installation

a. Removal



CREW COMPARTMENT



DRIVER'S COMPARTMENT

1 Remove clamp (1) and hose assembly (2) from coupling (3).

2 Remove coupling (3).

3 For crew compartment connector only, remove two screws (4), two lockwashers (5) and orifice connector and bracket (6).

4 Remove external retaining ring (7) and connector (8).

5 Remove screw (9), lockwasher (10), nut (11) (crew compartment only) and bracket (12).

b. Installation

Install in reverse order of removal.

CHAPTER 12
HULL STOWAGE

GENERAL

This chapter illustrates and defines procedures for removal, disassembly, assembly and installation of stowage racks, boxes and brackets for M109A2/M109A3 and M109A4 vehicles. The location for stowage of Basic Issue Items (BII) is also indicated within the chapter.

The procedures discussed in this chapter are in compliance with authorized organizational level maintenance responsibilities as defined in the Maintenance Allocation Chart (MAC).

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12-2 SPARE M45 PERISCOPE BOX 12-8
12-3 RATION BOX 12-9
12-4 PORTABLE FIRE EXTINGUISHER MOUNTING BRACKET, PROJECTILE SPACER BOX AND RIFLE STOWAGE CLIPS 12-10
12-5 FLASHLIGHT HOLDER AND CLGP EXTRACTOR 12-11
12-6 NBC SUIT STOWAGE BOX 12-12

HULL STOWAGE

12-1. HULL AMMUNITION RACKS

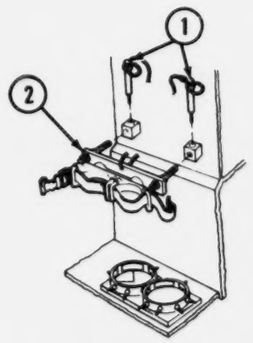
This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

INITIAL SET-UP

Material/Parts
Pads (35)
Cotter pins (2)
Adhesive (Item 2, App. C)
Sealing compound (Item 46, App. C)

a. Removal



CAUTION

Notify support maintenance as required for worn retaining web and metal straps and retaining brackets. Replace straps and brackets.

1 Remove two pins (1) from front right rack.

2 Remove bracket assembly (2).

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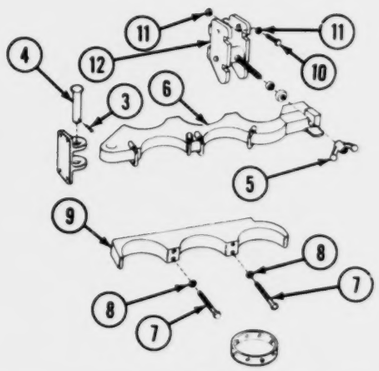


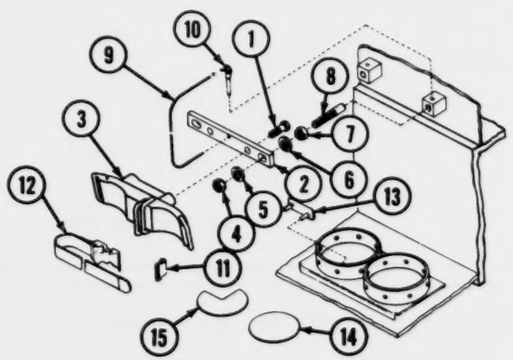
3 Remove cotter pin (3) and headed pin (4) from rear right or left rack. Discard cotter pin (3).

4 Remove wing nut (5) and arm (6).

5 Remove four screws (7), four washers (8) and cradle (9).

6 Remove two screws (10), two washers (11) and lock assembly (12).

b. Disassembly



1 Remove two screws (1) and plate (2) from front right rack bracket assembly (3).

2 Remove two nuts (4), two washers (5), two washers (6), two nuts (7) and two threaded rods (8) from plate (2).

3 Disconnect wire rope assembly (9) from two pins (10).

4 Remove two buckles (11) and two straps (12) from bracket assembly (3).

5 Remove eight bumpers (13), pad (14) and pad (15). Discard pads.

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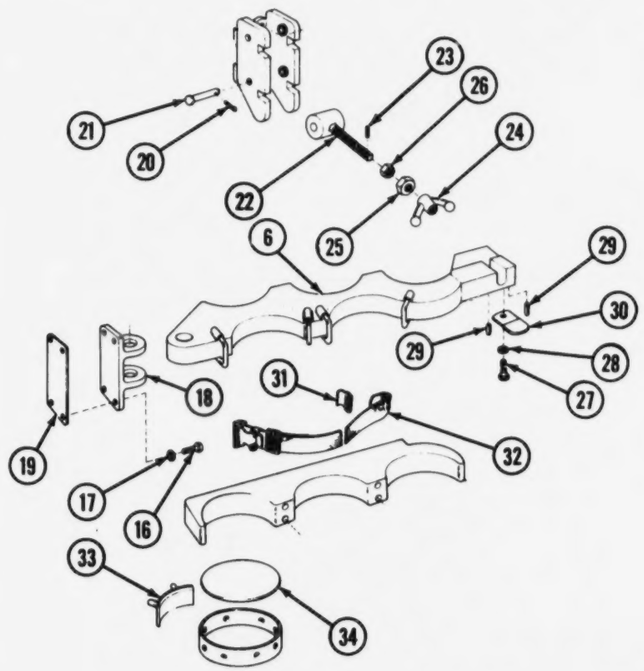
HULL STOWAGE - CONTINUED

12-1. HULL AMMUNITION RACKS - CONTINUED

b. Disassembly - Continued



6 Remove four screws (16), four washers (17), arm mounting bracket (18) and shim (19) of rear right or left ammunition rack from rear bulkhead.

7 Remove cotter pin (20), headed pin (21) and eyebolt (22). Discard cotter pin (20).

8 Remove pin (23), nut (24), jamnut (25) and nut (26).

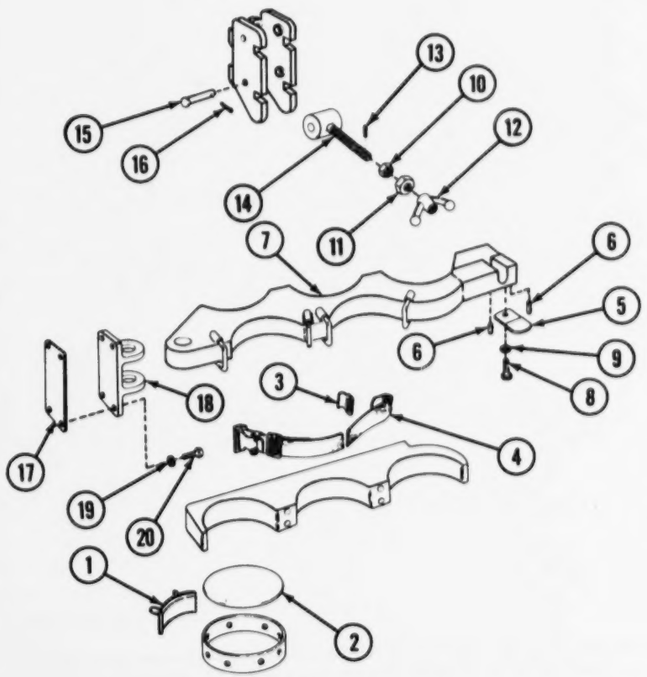
9 Remove screw (27), washer (28), two spring pins (29) and friction plate (30) from arm (6).

10 Remove two hooks (31) and two straps (32).

11 Remove 20 pads (33) and five pads (34).

TA472494

c. Assembly



1 Install 20 pads (1) and five pads (2) of the rear right or left ammunition rack.

2 Install two hooks (3) and two straps (4).

NOTE

Use sealing compound (Item 46, App. C) on all threads.

3 Install friction plate (5) and spring pins (6) on arm (7) with screw (8) and washer (9).

4 Install nut (10), jamnut (11), nut (12) and pin (13).

5 Install eyebolt (14) with headed pin (15). Replace cotter pin (16).

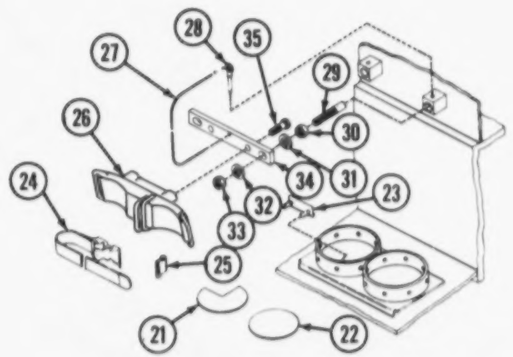
6 Install shim (17), arm mounting bracket (18), four washers (19) and four screws (20) to right rear or left ammunition rack from rear bulkhead.

TA472495

HULL STOWAGE - CONTINUED

12-1. HULL AMMUNITION RACKS - CONTINUED

c. Assembly - Continued



NOTE

Apply adhesive (Item 2, App. C) to pad (21) and pad (22).

7 Replace pad (21), pad (22) and eight pads (23) of front right rack assembly.

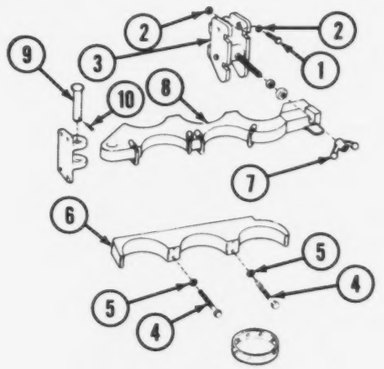
8 Install two straps (24) and two buckles (25) onto bracket assembly (26).

9 Reconnect wire rope assembly (27) to two pins (28).

10 Install two threaded rods (29), two nuts (30), two washers (31), two washers (32) and two nuts (33) onto plate (34).

11 Install plate (34) and two screws (35) onto front right rack bracket assembly (26).

TA472496



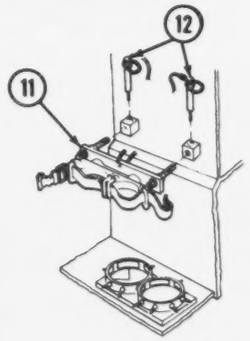
1 To install rear right or left rack, replace two screws (1), two washers (2) and lock assembly (3).

2 Replace four screws (4), four washers (5) and cradle (6).

3 Replace wing nut (7) and arm (8).

4 Replace headed pin (9).

5 Replace cotter pin (10).



6 To install front right bracket assembly, insert assembly (11) and replace two pins (12) to secure bracket securely.

TA472497

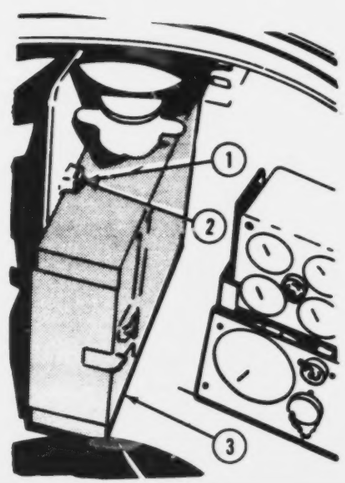
HULL STOWAGE - CONTINUED

12-2. SPARE M45 PERISCOPE BOX

This task covers:

a. Removal b. Installation

a. Removal



Remove four screws (1), four lockwashers (2) and periscope box (3).

b. Installation

Install in reverse order of removal.

TA472498

12-3. RATION BOX

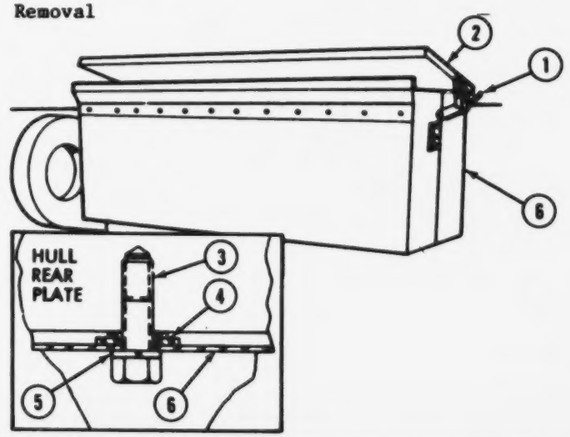
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Material/Parts
Seals (6)

a. Removal



1 Release latch (1) to open cover (2).

2 Remove six screws (3), six seals (4) and six lockwashers (5).

3 Remove ration box (6).

b. Installation

Install in reverse order of removal.

TA472499

HULL STOWAGE - CONTINUED

12-4. PORTABLE FIRE EXTINGUISHER MOUNTING BRACKET, PROJECTILE SPACER BOX AND RIFLE STOWAGE CLIPS

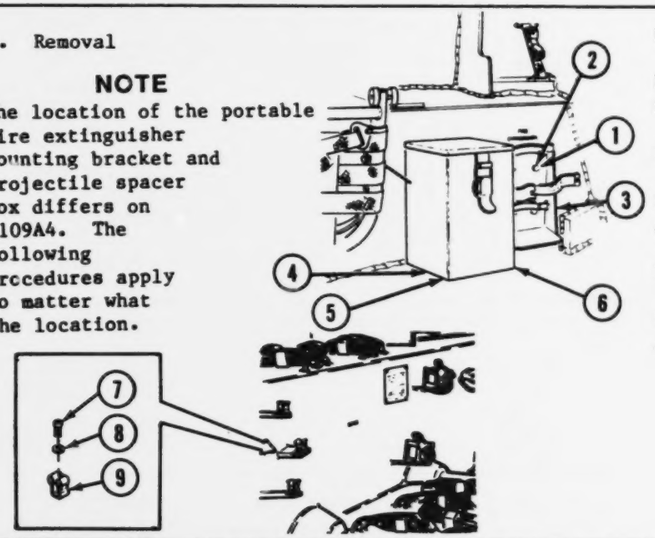
This task covers:

a. Removal b. Installation

a. Removal

NOTE

The location of the portable fire extinguisher mounting bracket and projectile spacer box differs on M109A4. The following procedures apply no matter what the location.



PORTABLE FIRE EXTINGUISHER MOUNTING BRACKET

Remove four screws (1), four lockwashers (2) and fire extinguisher bracket (3).

PROJECTILE SPACER BOX

Remove four screws (4), four lockwashers (5) and projectile spacer box (6).

RIFLE STOWAGE CLIP

Remove five screws (7), five lockwashers (8) and five rifle stowage clips (9).

NOTE

Four rifle stowage clips - crew compartment
One rifle stowage clip - driver's compartment

b. Installation

Install in reverse order of removal.

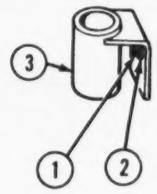
TA472500

12-5. FLASHLIGHT HOLDER, CLGP EXTRACTOR

This task covers:

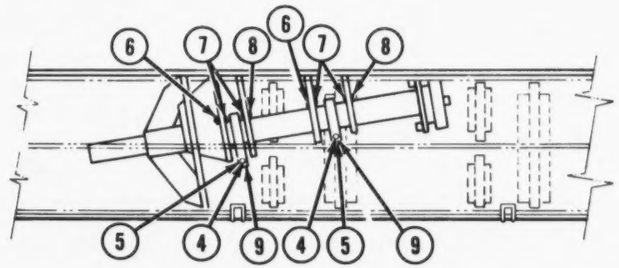
a. Removal b. Installation

a. Removal



FLASHLIGHT HOLDER

Remove two screws (1), two lockwashers (2) and holder (3).



CLGP TACTICAL EXTRACTOR

Remove two screws (4), two washers (5), two cotter pins (6), two headed pins (7), four washers (8) and two clamps (9).

b. Installation

Install in reverse order of removal.

TA472501

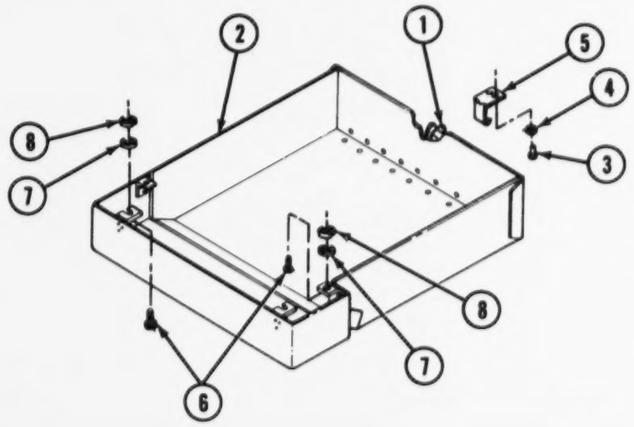
HULL STOWAGE - CONTINUED

12-6. NBC SUIT STOWAGE BOX

This task covers:

a. Removal b. Installation

a. Removal



NOTE

The following procedure applies to both the left and right stowage boxes.

1 Release latch (1) to open stowage box (2).

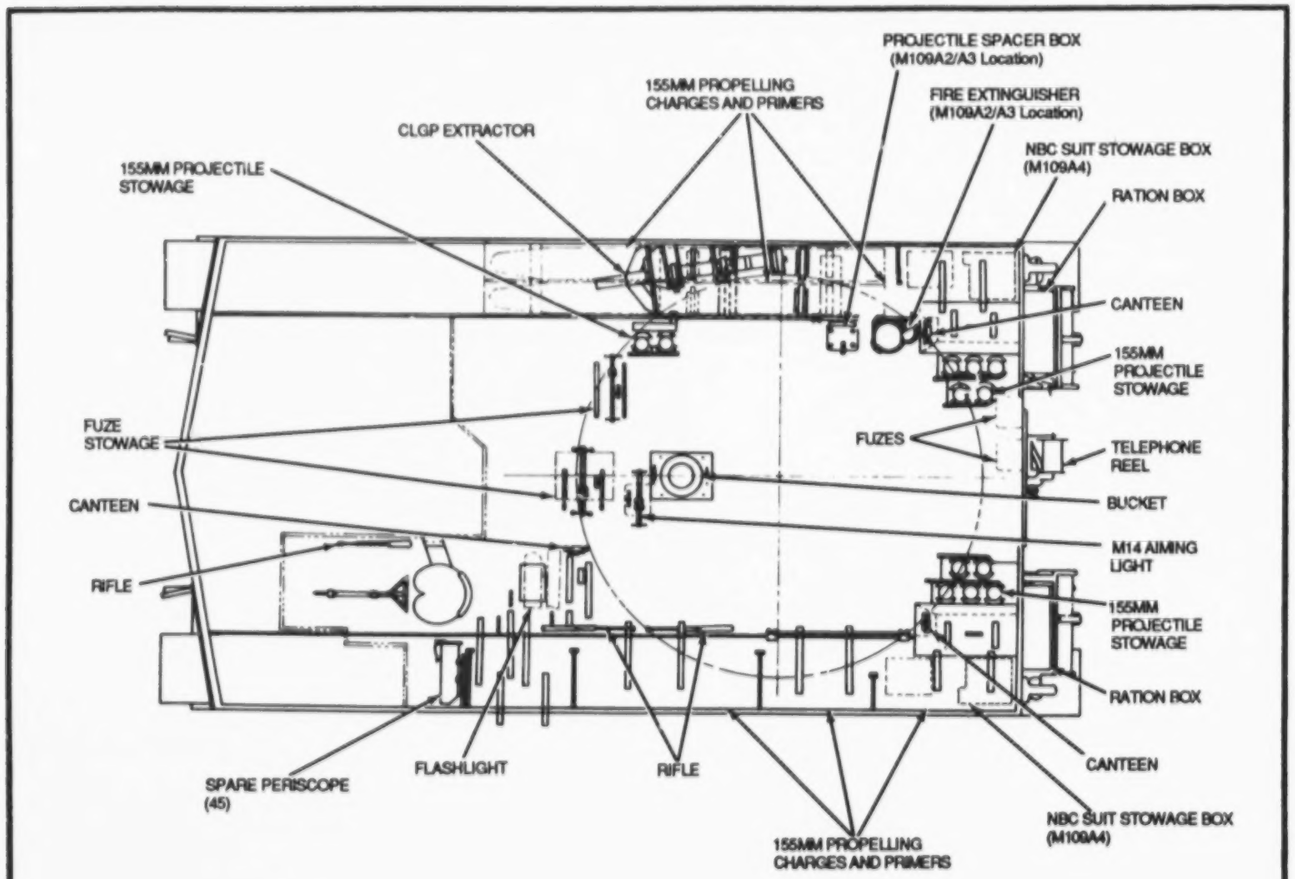
2 Remove two screws (3), two lockwashers (4) and latch (5).

3 Remove four screws (6), four lockwashers (7) and two washers (8) while supporting stowage box (2).

4 Remove NBC suit stowage box (2).

b. Installation

Install in reverse order to removal.



HULL INTERIOR STOWAGE DIAGRAM

TA472502

CHAPTER 13
ENGINE AND BATTERY WINTERIZATION KIT

GENERAL

This chapter illustrates and describes removal and installation instructions for specific components of M109A2/M109A3 and M109A4 Winterization Kit. Since the kit encompasses several components, each with an individual set of procedures, the chapter has been divided into the nine major components of the Winterization kit.

The Winterization Kit provides a standby heating system to prevent freezing of the engine coolant and battery electrolyte during shutdown periods in extreme cold or arctic temperatures. Coolant is circulated through the heater, engine, and battery heater by an electrically-driven coolant pump furnished with the kit.

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13-5	FUEL FILTER	13-8
13-6	COOLANT HEATER	13-9
13-7	COOLANT HEATER WIRING HARNESS	13-12
13-8	HEATER CONTROL BOX	13-15
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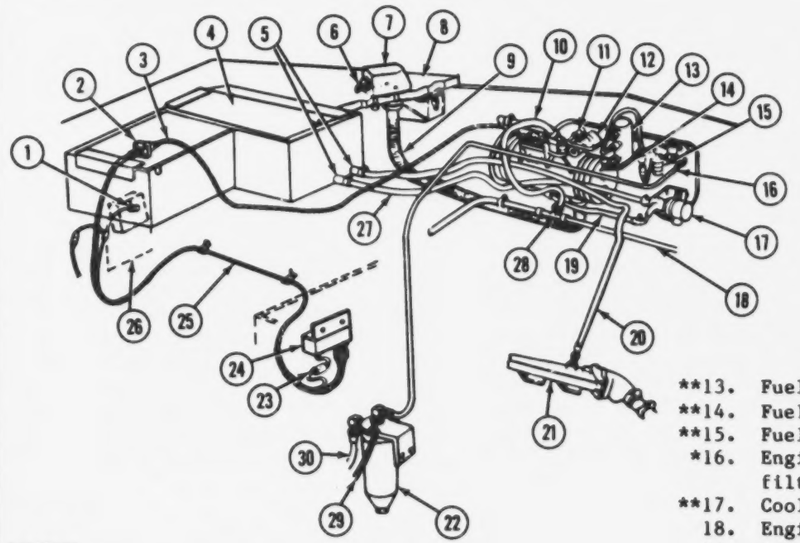


NOTE

This installed view of the winterization kit identifies all items in the kit. Those items which only need to be disconnected during powerplant removal are identified by a single *. Those items that need to be removed during powerplant removal are identified by a double **.

LEGEND

1. Connector (wire 459B) to master switch
2. Receptacle at driver's compartment bulkhead
*3. Bulkhead-to-heater, fuel pump, and coolant pump harness (wires 402B, 402C, 403B, 403C, 406, and ground)
4. Battery insulation box
5. Battery heater plate parts
6. Exhaust outlet plug
7. Exhaust outlet
8. Transmission left access door
**9. Exhaust tube
*10. Heater-to-surge tank hose connector tube
*11. Fuel pump-to-heater fuel tank
**12. Coolant heater
**13. Fuel pump (electric)
**14. Fuel filter-to-fuel pump fuel tube
**15. Fuel filter
*16. Engine fuel strainer (primary fuel filter) to fuel filter fuel hose
**17. Coolant pump (electric)
18. Engine coolant surge tank hose
19. Coolant pump-to-heater hose
*20. Engine coolant manifold-to-battery heater inlet hose
21. Engine manifold
22. Engine fuel strainer (primary filter)
23. Heater lead (wire 400)
24. Heater control box
25. Control box-to-master switch and bulkhead harness (wires 400, 402B, 402C, 406, and 459B)
26. Master switch (references)
*27. Battery heater outlet-to-coolant pump hose
28. Heater hose-to-surge tank hose Y-connector tube
30. Fuel tank to engine fuel strainer (primary filter) hose

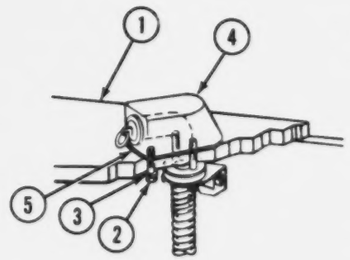
TA472503

13-1. EXHAUST OUTLET ASSEMBLY

This task covers:

a. Removal b. Installation

a. Removal



1 To remove exhaust outlet assembly, open left transmission access door (1).

2 Remove three screws (2) and three flatwashers (3).

3 Remove exhaust outlet (4) and gasket (5). Discard gasket.

b. Installation

1 Install in reverse order of removal.

2 Install new gasket (5).

TA472504

ENGINE AND BATTERY WINTERIZATION KIT - CONTINUED

13-2. BATTERY HEATER AND INSULATION BOXES

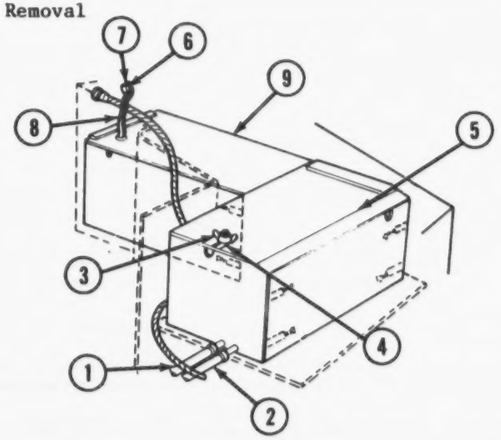
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Plugs - coolant tube (2)

a. Removal



1 Open battery access doors.

2 Disconnect battery heater inlet hose (1) and outlet hose (2). Install 5/8-inch (1.6-cm) diameter plugs in hoses. If plugs are not used, coolant must be drained (ref. TM 9-2350-311-10).

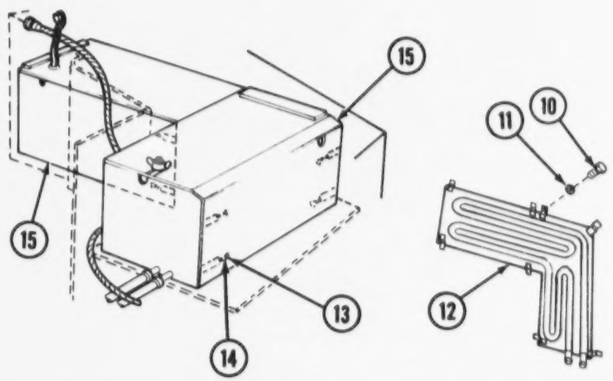
3 Remove wing nut (3), flatwasher (4) and front top insulation blanket (5).

4 Remove screw (6), lockwasher (7) and battery ground lead (8) at bulkhead.

5 Remove rear top insulation blanket (9).

6 Remove batteries and supports (ref. p. 8-57).

TA472505



7 Remove eight screws (10), eight lockwashers (11) and battery heater plate (12).

8 Remove lockwire (13), six retaining pins (14) (inside boxes) and two winterization boxes (15). (Lockwire and pins are located under boxes.)

b. Installation

Install in reverse order of removal.

TA472506

ENGINE AND BATTERY WINTERIZATION KIT - CONTINUED

13-3. COOLANT PUMP

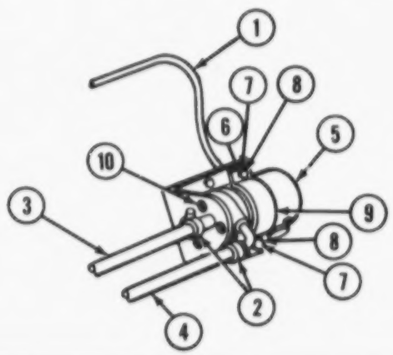
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Plugs - coolant tube (2)

a. Removal



1 Disconnect electrical lead (1).

2 Loosen two hose clamps (2) on coolant inlet hose (3) and outlet hose (4).

3 Disconnect hoses (3) and (4) from coolant pump (5) and install 5/8 inch (1.6 cm) plugs. If plugs are not used, coolant system must be drained (ref. TM 9-2350-311-10).

4 Remove two screws (6), two flatwashers (7), two nuts (8) and clamp bracket (9).

5 Remove three screws (10) and coolant pump (5).

b. Installation

Install in reverse order of removal.

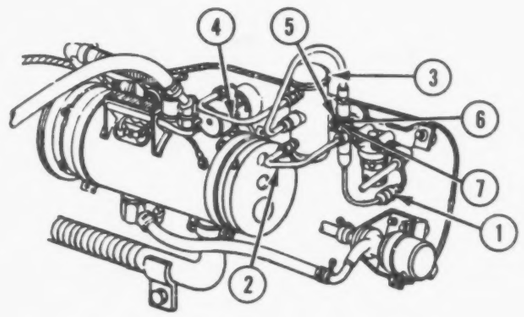
TA472507

13-4. FUEL PUMP

This task covers:

a. Removal b. Installation

a. Removal



1 Disconnect fuel inlet to fuel tank hose quick-disconnect at engine primary fuel filter (ref. p. 6-14).

2 Disconnect electrical connector (1) (wire 402C).

3 Disconnect fuel filter to fuel pump tube (2) at fuel pump (3).

4 Disconnect fuel pump to heater tube (4) at fuel pump (3).

5 Remove two nuts (5), two lockwashers (6), two flatwashers (7) and fuel pump (3).

b. Installation

Install in reverse order of removal.

TA472508

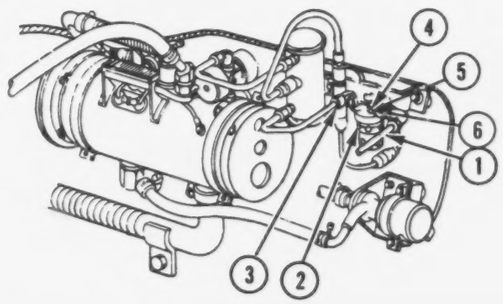
ENGINE AND BATTERY WINTERIZATION KIT - CONTINUED

13-5. FUEL FILTER

This task covers:

a. Removal b. Installation

a. Removal



1 Disconnect fuel inlet to fuel tank hose quick-disconnect at engine primary fuel filter (ref. p. 6-14).

2 Disconnect engine fuel strainer-to-fuel filter hose (1) at fuel filter (2).

3 Disconnect fuel filter-to-fuel pump tube (3) at fuel filter.

4 Remove two screws (4), two nuts (5), two flatwashers (6) and fuel filter (2).

b. Installation

Install in reverse order of removal.

TA472509

13-6. COOLANT HEATER (MODEL NO. 939J24)

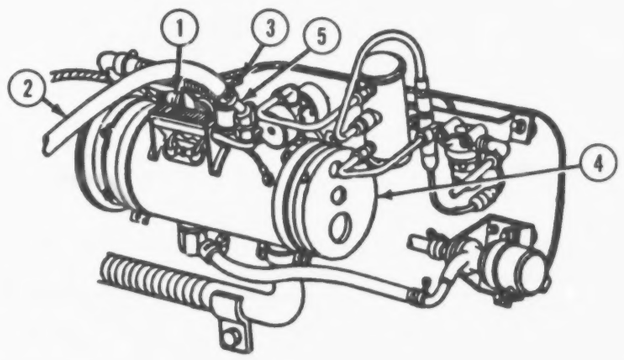
This task covers:

a. Removal b. Installation

INITIAL SET-UP

Materials/Parts
Plug - coolant tube

a. Removal



1 Disconnect fuel inlet to fuel tank hose quick-disconnect at engine primary fuel filter (ref. p. 6-14).

2 Disconnect wiring harness (1) at coolant heater plug.

NOTE

If hoses are not plugged and outlet is not capped, coolant system must be drained (ref. TM 9-2350-311-10).

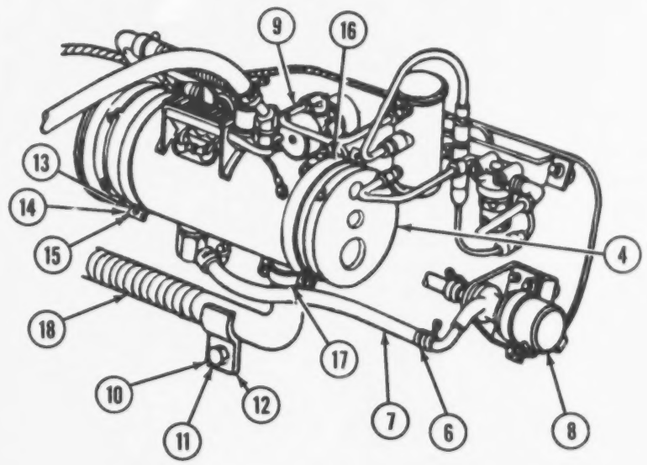
3 Loosen clamp (3) from coolant outlet hose (2) and disconnect hose from coolant heater (4). Cap heater coolant outlet (5) with a short piece of 5/8-inch (1.6 cm) id hose and 5/8-inch (1.6 cm) diameter plug.

TA472510

ENGINE AND BATTERY WINTERIZATION KIT - CONTINUED

13-6. COOLANT HEATER (MODEL NO. 939J24) - CONTINUED

a. Removal - Continued



4 Loosen inlet hose clamp (6) and disconnect hose (7). Install 5/8-inch (1.6 cm) diameter plug in coolant pump outlet.

5 Disconnect fuel pump-to-coolant heater tube (9) at coolant heater.

6 Remove screw (10), lockwasher (11) and clamp (12).

7 Remove four screws (13), four nuts (14), four flatwashers (15) and two coolant heater upper brackets (16).

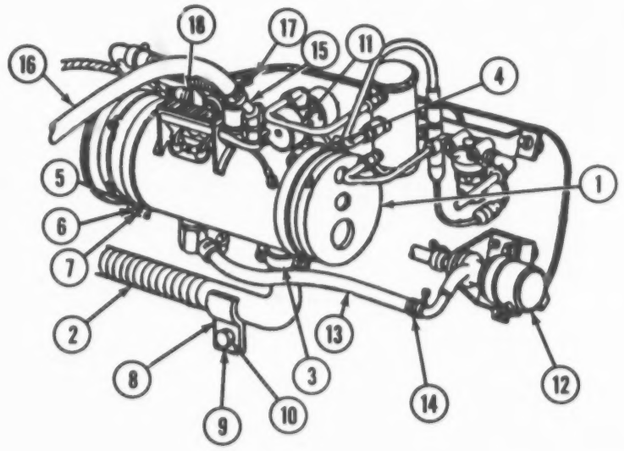
NOTE

Coolant heater must be lifted or tilted in order to reach exhaust tube clamps (17).

8 Loosen clamp (17) at heater exhaust hose (18) and disconnect hose. Remove coolant heater (4) from hull.

TA472511

b. Installation



NOTE

Coolant heater must be lifted or tilted in order to reach exhaust tube clamps (17).

1 To install coolant heater (1), connect heater exhaust hose (2) with clamp (3) to coolant heater.

2 Position two coolant heater brackets (4) over coolant heater and install with four flatwashers (5), four nuts (6) and four screws (7).

3 Secure heater exhaust hose (2) with bracket clamp (8) flatwasher (9) and screw (10).

4 Connect fuel pump to coolant heater fuel inlet tube (11) at coolant heater (1).

5 Remove plug of the coolant pump outlet (12) if necessary and install coolant inlet hose (13) with clamp (14).

6 Remove cap on heater coolant outlet (15) and plug from coolant heater hose (16) if necessary. Install coolant outlet hose (15) on coolant hose outlet (16) with clamp (17).

7 Connect wiring harness (18) at coolant heater plug.

TA472512

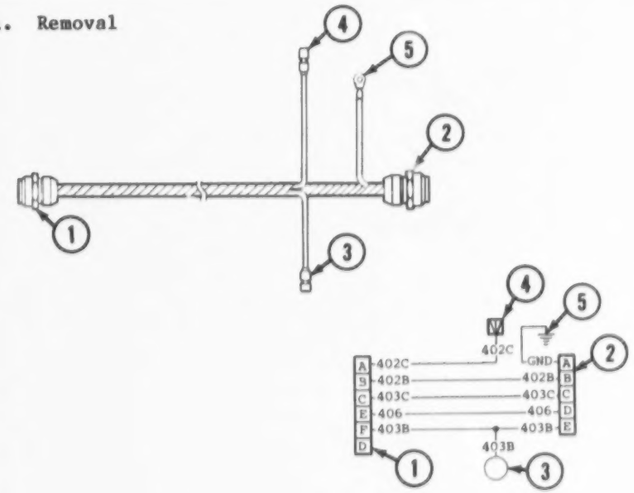
ENGINE AND BATTERY WINTERIZATION KIT - CONTINUED

13-7. COOLANT HEATER WIRING HARNESSES

This task covers:

a. Removal b. Disassembly c. Assembly d. Installation

a. Removal



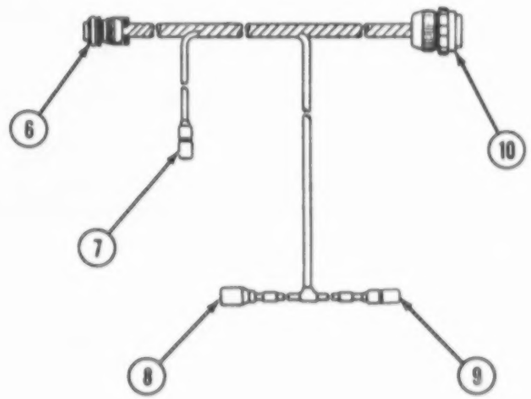
COOLANT HEATER-TO-BULKHEAD WIRING HARNESS

Remove coolant heater wiring harnesses in numerical order of legend and illustrations.

LEGEND

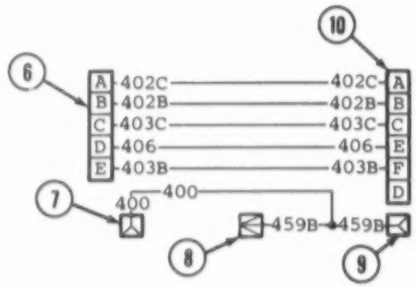
1. Connector-to-driver's compartment bulkhead
2. Connector coolant heater
3. Terminal-circulating pump
4. Connector fuel pump
5. Terminal ground

TA472513



6. Connector heater control box
7. Connector heater control box (wire 400)
8. Connector harness 10930473 to master switch
9. Connector control circuit rectifier
10. Connector driver's compartment bulkhead

BULKHEAD-TO-COOLANT HEATER
CONTROL BOX WIRING HARNESS



TA472514

ENGINE AND BATTERY WINTERIZATION KIT - CONTINUED

13-7. COOLANT HEATER WIRING HARNESSES - CONTINUED

b. Disassembly

Disassemble harnesses in accordance with Chapter 2 (ref. p. 2-23).

c. Assembly

Assemble in reverse order of disassembly.

d. Installation

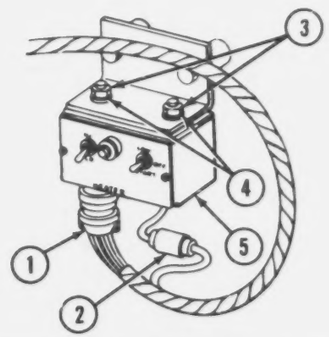
Install in reverse order of removal.

13-8. HEATER CONTROL BOX

This task covers:

a. Removal b. Installation

a. Removal



1 Disconnect plug (1) at control box.

2 Disconnect connector (2) at control box.

3 Remove two nuts (3), two lockwashers (4) and heater control box (5).

b. Installation

Install in reverse order of removal.

TA472515

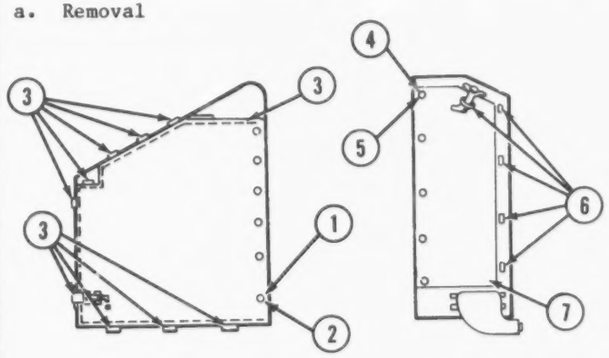
ENGINE AND BATTERY WINTERIZATION KIT - CONTINUED

13-9. GRILLE COVERS

This task covers:

a. Removal b. Installation

a. Removal



1 To remove cover (tarpaulin) for the air intake grille, remove six screws (1) and six washers (2).

2 Disconnect ten strap assemblies (3) and remove air intake grille tarpaulin (4).

3 Install six washers (2) and six screws (1).

4 To remove tarpaulin for the exhaust grille, remove five screws (5) and five washers (6).

5 Disconnect five strap assemblies (7) and remove exhaust grille tarpaulin (8).

6 Install five washers (6) and five screws (7).

b. Installation

NOTE

Prior to installation, visually inspect for torn, deteriorated, or damaged covers (tarpaulins) and tiedown straps and repair or replace or notify appropriate maintenance level.

1 To install cover (tarpaulin) for the air intake grille, reverse order of removal.

2 To install cover (tarpaulin) for the exhaust grille, reverse order of removal.

TA472516

CHAPTER 14
DEPROCESSING AND COMBAT LOADING OF VEHICLE

GENERAL

This chapter provides step-by-step detailed procedures for deprocessing the vehicle and basic issue items, and combat loading of the M109A2, M109A3 and M109A4 hull systems.

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SECTION I. DEPROCESSING THE VEHICLE

14-1 CLOSURE KIT: REMOVAL AND STORAGE 14-2
14-2 PADDINC AND BASIC ISSUE ITEM BOXES: REMOVAL 14-4
14-3 TAPE REMOVAL 14-5
14-4 VENTILATION SCREENS AND ACCESS COVERS: REMOVAL AND INSTALLATION 14-6

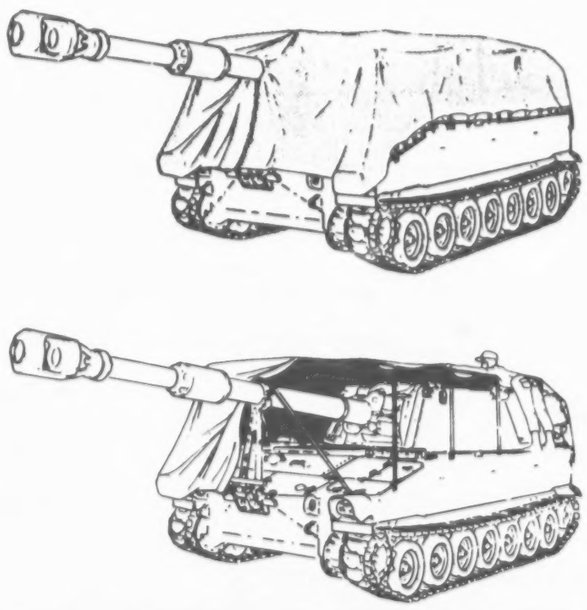
SECTION II. DEPROCESSING OF BASIC ISSUE ITEMS AND COMBAT LOADING OF VEHICLE

14-5 DEPROCESSING BASIC ISSUE ITEMS 14-7
14-6 COMBAT LOADING 14-8

DEPROCESSING AND COMBAT LOADING OF VEHICLE - SECTION I. DEPROCESSING THE VEHICLE

This section illustrates and describes deprocessing of the vehicle, removal of the vehicle closure kit, padding from the extending points, basic issue item boxes, saddle, tape, howitzer cannon muzzle plug, breechblock wooden shipping block, bottom ventilation screens, and combat loading of the vehicle.

14-1. CLOSURE KIT: REMOVAL AND STORAGE



1 Loosen side ropes (two on each side).

2 Remove tie-down ropes at rear of vehicle.

3 Remove corner ropes at rear of vehicle.

4 Untie front corner ropes.

5 Remove vehicle front ropes.

6 Unlace ropes from front eyelets.

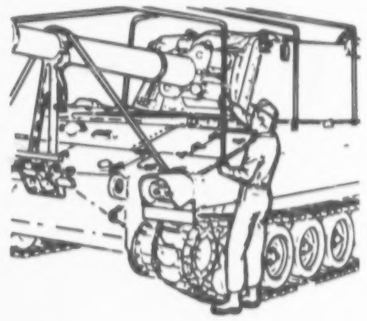
7 Unlace ropes from eyelets on front corners.

8 Remove guide ropes from side wire struts.

9 Remove all ropes from eyelets.

10 Fold cover on sides to center point of frame assembly and remove cover.

TA472517



11 Remove frame assembly and store in secure location.

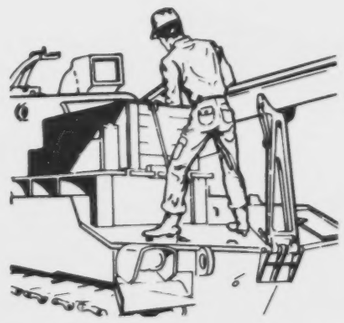
12 Fold vehicle covers and stow in cab right stowage basket.

TA472518

DEPROCESSING AND COMBAT LOADING OF VEHICLE - SECTION I. DEPROCESSING THE VEHICLE - CONTINUED

14-2. PADDING AND BASIC ISSUE ITEM BOXES: REMOVAL

1 Remove padding from extending point.



2 Remove basic issue item boxes from hull compartment.

TA472519

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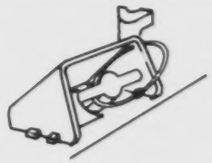
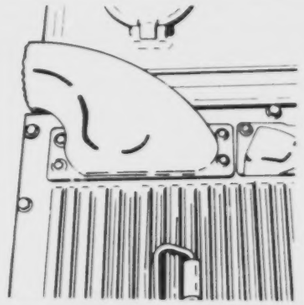
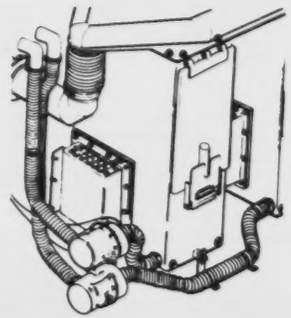
14-3. TAPE REMOVAL



1 Remove tape from fire extinguisher bracket.



2 Remove tape from engine exhaust outlet.



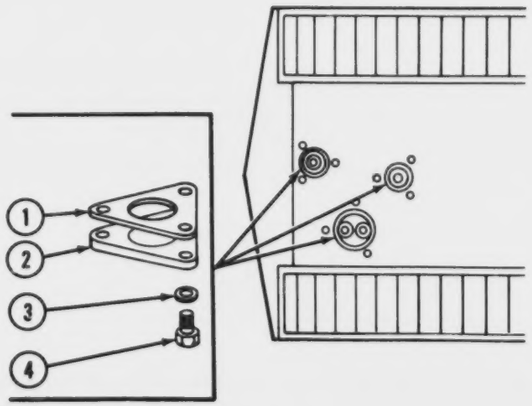
3 Remove sealing tape from air cleaner inlet in crew compartment.

TA472520

DEPROCESSING AND COMBAT LOADING OF VEHICLE - SECTION I. DEPROCESSING THE VEHICLE - CONTINUED

14-4. VENTILATION SCREENS AND ACCESS COVERS: REMOVAL AND INSTALLATION

1 Remove three screens from bottom of hull.



2 To install access covers, place gasket (1) on hull and place cover (2) on gasket. Install washer (3) and screw (4).

TA472521

DEPROCESSING AND COMBAT LOADING OF VEHICLE - SECTION II. DEPROCESSING OF BASIC ISSUE ITEMS AND COMBAT LOADING OF VEHICLE

This section illustrates the deprocessing of Basic Issue Items. This deprocessing should be accomplished with the crew present.

14-5. DEPROCESSING BASIC ISSUE ITEMS

Open all large containers and inventory contents with packing slip furnished. Record each item missing. Compare the contents with TM 9-2350-311-10 to ensure BII are present.

Install fire control and sighting equipment as is. No cleaning is required.

Clean all other tools and equipment.

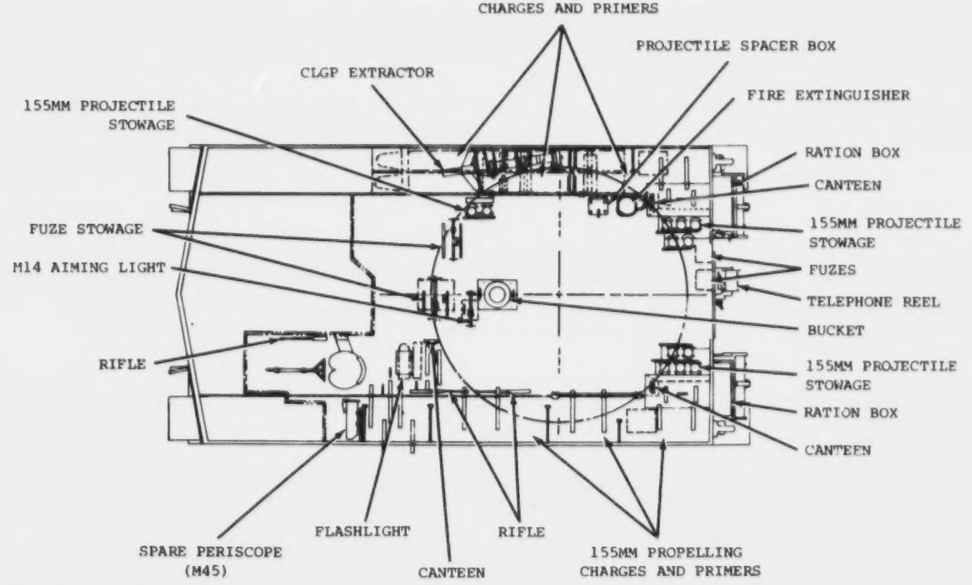
As required, store all basic issue items in their respective vehicle storage facility as indicated in TM 9-2350-311-10.

DEPROCESSING AND COMBAT LOADING OF VEHICLE - SECTION II. DEPROCESSING OF BASIC ISSUE ITEMS AND COMBAT LOADING OF VEHICLE - CONTINUED

14-6. COMBAT LOADING

Combat loading of the howitzer is primarily a crew responsibility and should be accomplished in accordance with the following illustration.

155MM PROPELLING CHARGES AND PRIMERS



TA472522

CHAPTER 15
PREPARATION FOR SHIPMENT AND STORAGE

GENERAL

This chapter provides specific instructions for shipping, receiving, storage, inspection and destruction to prevent enemy usage of the M109A2, M109A3 and M109A4 howitzer.

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SECTION I. SHIPMENT AND STORAGE

15-1 SHIPPING INSTRUCTIONS 15-2
15-2 REMOVAL OF PRESERVATIVES PRIOR TO SHIPMENT 15-2
15-3 ARMY SHIPPING DOCUMENTS 15-2

SECTION II. LIMITED STORAGE INSTRUCTIONS

15-4 RECEIVING INSPECTIONS 15-3
15-5 INSPECTION DURING STORAGE 15-3
15-6 REMOVAL FROM LIMITED STORAGE 15-4
15-7 LOADING 15-4
15-8 BLOCKING 15-5

PREPARATION FOR SHIPMENT AND STORAGE - SECTION I. SHIPMENT AND STORAGE

15-1. SHIPPING INSTRUCTIONS

When shipping the M109A2/M109A3 or M109A4 self-propelled howitzer, the officer in charge of preparing the shipment will be responsible for furnishing the materiel in serviceable condition, properly cleaned, processed, packaged and packed.

15-2. REMOVAL OF PRESERVATIVES PRIOR TO SHIPMENT

Personnel withdrawing the vehicle from storage for shipment must not remove preservatives other than to ensure that the materiel is complete and serviceable. If preservatives have been removed, they must be restored to prescribed level of preservation prior to shipment.

15-3. ARMY SHIPPING DOCUMENTS

Prepare all Army shipping documents in accordance with AR 5-355.

PREPARATION FOR SHIPMENT AND STORAGE - SECTION II. LIMITED STORAGE INSTRUCTIONS

When received for storage and already processed for domestic shipment by the manufacturer as indicated on DD Form 1397, the vehicle will not be reprocessed unless inspection performed on receipt of materiel reveals corrosion, deterioration, etc.

Upon receipt from manufacturing facilities, if the processing data on the tag indicates that preservation has been rendered ineffective by operation or by freight shipping damage, completely process the vehicle. Refer to TM 9-2350-311-20-2 for administrative storage requirements.

15-4. RECEIVING INSPECTIONS

Immediately upon receipt of the vehicle for storage, it must be inspected and serviced as prescribed. Perform a systematic inspection. Replace or repair all missing or broken parts. If repairs are beyond the scope of the unit, and materiel will be inactivated for a considerable length of time, place materiel in limited storage and attach tags specifying the repairs needed. The report of these conditions will be submitted by the unit commander for action by an ordnance maintenance unit.

When materiel is inactivated for a limited time (not to exceed 90 days), it will be processed in accordance with TM 740-90-1.

Prepare an SF 364 Form for all shipments received in a damaged or otherwise unsatisfactory condition due to deficiencies in preservation, packaging, marking, handling, loading, or storage, and for apparently excessive preservation.

The preferred storage site for vehicles is in dry covered sheds. When it is necessary to store materiel outdoors, protect it against the elements as prescribed in SB 740-1 and TM 743-200.

15-5. INSPECTION DURING STORAGE

Perform a visual inspection periodically to determine general condition. If corrosion is found, remove it and clean, paint, and treat vehicle with the prescribed preservatives.

NOTE

Touch-up painting will be in accordance with TM 43-0139.

Vehicle to be prepared for administrative storage must be given a limited technical inspection and processed as prescribed on DD Form 1397. The results of the inspection and classification will be entered on DA Form 2404.

PREPARATION FOR SHIPMENT AND STORAGE - SECTION II. LIMITED STORAGE INSTRUCTIONS - CONTINUED

15-6. REMOVAL FROM LIMITED STORAGE

If a vehicle is not shipped or issued upon expiration of the limited storage period, process as applicable in accordance with MIL-H-46709.

If a vehicle to be shipped will reach its destination within the limited storage period, it need not be reprocessed when removed from storage, unless necessary because of anticipated in-transit weather conditions.

When the vehicle is to be placed into service, immediately deprocess in accordance with instructions on DD Form 1397.

15-7. LOADING

CAUTION

The height and width of a vehicle, when prepared for rail transportation, must not exceed the limitations prescribed for particular railroad lines. Whenever possible, local transportation officers must be consulted about the limitations of the particular railroad lines to be used for the movement in order to avoid delays, dangerous conditions, or damage to equipment.

When a vehicle is shipped by rail, every precaution must be taken to see that it is properly loaded, blocked, and securely fastened to the flatcar floor.

Inspect flatcar prior to loading and see that it is in a suitable condition to carry loads safely.

Prepare flatcar for loading by removing debris, previous blocking, nails, and other obstructions. Inspect flatcar for loose or broken floor planks. If found unsatisfactory, reject car for use.

If suitable hoisting equipment, permanent loading ramps, and handling equipment are not available for loading or unloading materiel, improvised runways, ramps, and spanning platforms can be constructed.

Loading must be governed by the capacity and length of flatcars available at time of shipment, as well as requirements of bills of lading and shipping instructions.

CAUTION

The howitzer cannon must never extend beyond end of the flatcar.

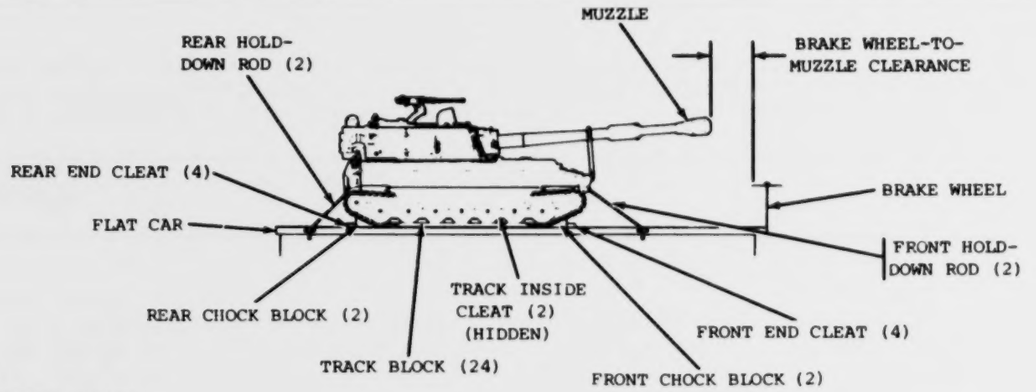
Position the vehicle as far from the brake wheel end of the flatcar as space permits. Provide a minimum clearance of 4 inches (10.2 cm) below and 6 inches (15.2 cm) above, behind, and to each side of the flatcar brake wheel.

15-8. BLOCKING

All blocking instructions specified herein are minimum and are in accordance with the Association of American Railroads Pamphlet, Section No. 6 (Rules Governing the Loading of Department of Defense Materiel on Open-Top Cars). Additional blocking may be added at the discretion of the officer in charge.

PREPARATION FOR SHIPMENT AND STORAGE - SECTION II. LIMITED STORAGE INSTRUCTIONS - CONTINUED

15-8. BLOCKING - CONTINUED



TRACK INSIDE CLEATS

Locate cleats (6 in. x 6 in. x 14 ft (15.2 cm x 15.2 cm x 4.3M), two required) along the inside of the left and right tracks. Nail to car floor with 30-penny nails, staggered approximately every 12 inches (30.4 cm).

CHOCK BLOCK - EXPLODED AND ASSEMBLED VIEWS

TA472523

CHOCK BLOCK

Construct four chock blocks: two to fit the angle between the tracks and car deck at the front of the vehicle, and two to fit the angle between the track and car deck at the rear of the vehicle. Using 1-5/8 inch (4.1 cm) thick lumber, make chock blocks 12 inches (30.4 cm) wide and a minimum of 18 inches (45.72 cm) high. Nail pieces together with 20-penny nails. Locate one chock block against the front of each track, and one against the rear of each track. Toenail the chock blocks to the car floor with 40-penny nails.

END CLEATS

Locate one cleat 2 x 4 x 12 inches (5 x 10.2 x 30.4 cm), eight required) against the end of each chock block and secure to car deck with 30-penny nails. Locate the upper cleat on top of the lower cleat and secure to lower cleat with 30-penny nails.

SIDE CLEAT

Locate one cleat (2 x 3 x 10 inches (5 x 7.6 x 25 cm), eight required) against the inside and outside of each of the chock blocks. Secure each car deck with 20-penny nails.

TRACK BLOCKS

Cut blocks (34 required) to conform with the shape of road wheels. Locate blocks on tracks between wheels. Place wedges under block to ensure a snug fit against wheels, if required. Nail 2 x 4 cleat (length to suit) across top of blocks to prevent track blocks from sliding out of position.

HOLDDOWN RODS

Thread both ends of rod (1-1/4 inch (3.2 cm) diameter, length to suit). Insert one end of rod through lifting eye on front of vehicle. Bend rod and insert other end through stake pocket on opposite side of flatcar. Repeat operation with second rod and lifting eye on front of vehicle. Repeat operations with two rods on rear of vehicle.

APPENDIX A
REFERENCES

GENERAL

The following publications constitute a listing of publications applicable to Organizational Maintenance for materiel covered in this technical manual. Appropriate indexes should be consulted frequently for latest applicable changes, revisions and additions.

REGULATIONS

AR 310-25
Dictionary of United States Army terms

AR 310-50
Authorized abbreviations and brevity codes

AR 385-40
Accident reporting and records

AR 385-55
Prevention of motor vehicle accidents

AR 746-1
Packaging of Army Materiel for Shipment and Storage

AR 75-1
Malfunctions involving ammunition and explosives

MANUALS

FM 5-25
Explosives and demolition

FM 3-5
NBC decontamination
Subscription form: 12-11A-R BLK 0737

FM 21-11
First Aid

TM 3-6680-316-10
Operator's manual for tester, airflow, gas particulate filter unit: M39

TM 10-277
Chemical, toxicological and missile fuel handlers protective clothing

TM 11-5830-340-12
Operator's and Organizational maintenance manual including repair parts and special tools lists:
Intercommunication set AN/VIC-1 (V)

TM 11-6625-203-12
Operator's, Organizational, DS, GS and Depot maintenance manual: Multimeter AN/URM105

TM 11-6625-3052-14
Operator's Organizational, Direct Support and General Support maintenance manual: Multimeter, Digital, AN/PSM-45

TM 38-230-1
Packaging of materiel: preservation (VOL I)

TM 38-230-2
Packaging of materiel: packing (VOL II)

DA PAM 738-750
The Army Maintenance Management System (TAMMS)

DA PAM 750-33
Charging System Troubleshooting

TM 43-0139
Painting instructions for field use

TM 740-90-1
Administrative storage of equipment

TM 743-200
Storage and materials handling

TM 750-116
Organizational, Direct Support and General Support maintenance procedures for purging and charging of fire control instruments

TM 750-138
Procedures for rapid deployment, redeployment and retrograde for combat vehicles

TM 750-244-3
Procedures for destruction of equipment to prevent enemy use

TM 9-1005-213-10
Operator's manual: Machine gun, cal. .50; Browning, M2, heavy barrel, flexible

TM 9-1005-213-25
Organizational, DS, GS and Depot maintenance manual including repair parts and special tool lists: Machine gun, cal. .50; Browning, M2 heavy barrel, flexible

TM 3-6680-316-10
Operator's manual: Tester, Airflow, Gas-Particulate Filter Unit: M39

TM 9-1005-245-14
Operator, Organizational, DS and GS maintenance manual including repair parts and special tool lists (including Depot maintenance repair parts and special tools): Various machine gun mounts and combinations used on tactical and armored vehicles

TM 9-2300-422-23&P
Army oil analysis program

TM 9-2350-311-10
Operator's manual: Howitzer, self-propelled: 155MM, M109A2 (2350-01-031-0586), M109A3 (2350-01-031-8851) and M109A4 (2350-01-277-5770)

TM 9-2350-311-20-2
Organizational maintenance manual for cab, armament, sighting and fire control, elevating and traversing systems and associated components used on Howitzer, medium, self-propelled: 155MM, M109A2 (2350-01-031-0586), M109A3 (2350-01-031-8851) and M109A4 (2350-01-277-5770)

TM 9-2350-311-20P-2
Organizational, maintenance repair parts and special tool lists: Cab, armament, sighting and fire control, elevating and traversing systems and associated components used on howitzer, medium, self-propelled: 155MM, M109A2 (2350-01-031-0586), M109A3 (2350-01-031-8851) and M109A4 (2350-01-277-5770)

TM 9-2350-311-24P-1
Organizational, Direct Support and General Support maintenance repair parts and special tools lists: Howitzer, medium, self-propelled: 155MM, M109A2 (2350-01-031-0586), M109A3 (2350-01-031-8851) and M109A4 (2350-01-277-5770)

TM 9-2540-205-24&P
Organizational, Direct Support and General Support maintenance manual (including repair parts and special tools lists) for combat vehicle personnel heaters. Hupp MF510A, Multi-Fuel, 6000 BTU, NSN 2540-00-930-8938. Hupp MF510B, Multi-Fuel, 6000 BTU, NSN 2540-01-071-0652. Stewart Warner 10560C, Multi-Fuel, 6000 BTU, NSN 2540-01-083-0691. Stewart Warner 10560M, Multi-Fuel, 6000 BTU, NSN 2540-01-071-0651. Stewart Warner 8460-C24, Multi-Fuel, 2540-00-854-4449. ESPAR Products V7S, Diesel, 40,000 BTU, NSN 2540-01-114-7688.

TM 9-2920-258-30&P
Intermediate Direct Support Maintenance Manual Including Repair Parts and Special Tools List: Generator, Alternating current, 180 amperes, Model 5520AB

TM 9-4910-571-12&P
Operator and Organizational maintenance manual including repair parts and special tools lists and Simplified Test Equipment for Internal Combustion Engines (STE/ICE)

TM 9-6140-200-14
Operator's, Organizational, Direct Support and General Support maintenance manual for lead-acid storage batteries

BULLETINS

TB SIG 222
Solder and soldering

TB 750-651
Use of antifreeze solutions and cleaning compounds in engine cooling systems

TB 9-1000-234-35
Exercising of recoil mechanism and equilibrators

TB 9-2300-421-20
Domelight lens replacement

SB 740-98-1
Storage Serviceability Standard: Tracked Vehicle, wheeled vehicles, and components parts

TB 43-0001-39-4
Road wheel oil to grease conversion

TB 43-0209
Color marking and camouflage painting of military vehicles, construction equipment and materials handling equipment

LUBRICATION ORDER

LO 9-2350-311-12
Howitzer, medium, self-propelled: 155MM, M109A2 (2350-00-031-0586) and M109A3 (2350-01-031-8851)

FORMS

DA Form 2028
Recommended change to publications

DD Form 2028-2
Recommended change to equipment technical manuals

DA Form 2402
Exchange Tag

DA Form 2404
Equipment inspection and maintenance worksheet

DA Form 2407
Maintenance request

DA Form 2408-14
Uncorrected fault record

DA Form 285
Accident report

DD Form 1397
Processing and deprocessing record for shipment, storage and issue of vehicles and spare engines

DD Form 6
Report of damaged or improper shipment

APPENDIX B
MAINTENANCE ALLOCATION CHART

SECTION I. INTRODUCTION

B-1. GENERAL

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance levels.

b. The Maintenance Allocation Chart (MAC) in Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance function upon the end item or component will be consistent with the assigned maintenance functions.

c. Section III lists the Special Tools and Test Equipment required for each maintenance function as referenced from Section II.

B-2. MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows (except for ammunition MAC):

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical and/or electrical characteristics with established standards through examination.

b. Test. To verify serviceability and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating conditions, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust. To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Aline. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipments used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install. The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. Replace. The act of substituting of a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair. The application of maintenance service or other maintenance actions to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhaul. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those service/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipment/components.

B-3. COLUMN ENTRIES.

Columns used in the maintenance allocation chart will be limited to those shown. Entries for these columns are explained below:

a. Column 1. Group number, column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies and modules with the next higher assembly.

b. Column 2. Component/assembly, Column 2 contains the noun names of components, assemblies, subassemblies and modules for which maintenance is authorized.

c. Column 3. Maintenance Functions, Column 3 lists the functions to be performed on the item listed in Column 2.

d. Column 4. Maintenance Category, Column 4 specified, by the listing of a "work time" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, approximate "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical operating condition. This time includes preparation time, troubleshooting time and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance levels are as follows:

C.....Operator or crew
O.....Organizational maintenance
F.....Direct Support maintenance
H.....General Support maintenance
D.....Depot maintenance
*.....Work times are included in DMWR

e. Column 5. Tools and Equipment, Column 5 specified by code, those common tool sets and special tools, test, and support equipment required to perform the designated function.

f. Column 6. Remarks, Column 6 contains an alphabetic code.

Exception is authorized for ammunition MAC to permit the redesignation of maintenance function headings to more adequately identify ammunition maintenance functions. The heading designations and definitions will be included in the appropriate technical manual for each category of ammunition.

Services - inspect, test, service, adjust, aline, calibrate, or replace.
Actions - welding, grinding, riveting, straightening, facing, remachining, or resurfacing.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS (SECTION III).

a. Reference Code. The tool and TMDE reference code correlates with a code used in the MAC, Section II, Column 5.

b. Maintenance Level. The lowest level of maintenance authorized to use the tool or test equipment.

c. Nomenclature. Name or identification of the tool or test equipment.

d. National Stock Number. The National stock number of the tool or TMDE.

e. Tool Part Number. The USER's part identification.

SECTION II. MAINTENANCE ALLOCATION CHART FOR HULL, TRACKS, SUSPENSION AND ASSOCIATED COMPONENTS - HOWITZER, MEDIUM, SELF PROPELLED 155MM, M109A2/M109A3

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category *					Tools and Equipment	Remarks
			C	O	F	H	D		
01	ENGINE								
0100	POWERPLANT	INSPECT		0.5					
		TEST		0.4				24,25	
		SERVICE	0.8					26,27,28,29, 30,31	
		REPLACE		9.0				32	
	ENGINE	INSPECT		0.5					
		TEST		0.2				2,33	
		SERVICE	1.0						
		ADJUST			3.0				
		REPLACE			8.0			35	
		REPAIR			20.0				
		OVERHAUL				48.0	**		
	MOUNT, ENGINE	INSPECT		0.1					
		REPLACE		1.0				34	
		REPAIR		2.0					

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category *					Tools and Equipment	Remarks
			C	O	F	H	D		
0101	HEAD, CYLINDER	INSPECT			1.2				
		REPLACE			2.8				
		REPAIR			3.3	4.2			
0102	DAMPER, VIBRATION	INSPECT			0.5				
		REPLACE			0.5				
0103	FLYWHEEL	INSPECT			0.5				
		REPLACE			0.5				
		REPAIR			1.0				
0105	VALVES	INSPECT			0.4				
		ADJUST			1.0				
		REPLACE			1.0				
		REPAIR			1.0				
0106	FILTER, OIL	INSPECT		0.3					
		SERVICE		0.3					
		REPLACE		0.5					
		REPAIR		0.3					

	OIL PUMP	INSPECT			0.2						
		ADJUST				0.2					
		REPLACE				2.3					
		REPAIR				1.5					
	CORE, OIL COOLER	INSPECT			0.5						
		REPLACE			1.1						
		REPAIR			2.0						
	LINES AND FITTINGS (OIL EXTERNAL)	INSPECT	0.3								
		REPLACE		0.3							
0108	MANIFOLD, EXHAUST	INSPECT			0.2						
		REPLACE			2.0						
03	FUEL SYSTEM										
0301	INJECTOR, FUEL	INSPECT			0.2						
		TEST			0.2						
		ADJUST			0.1						
		REPLACE			0.2						
		REPAIR			0.7	1.5					
0302	PUMP, FUEL (& HANGER ASSY LEFT & RIGHT)	INSPECT		0.2							
		TEST		0.2							

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category *					Tools and Equipment	Remarks
			C	O	F	H	D		
		REPLACE		0.2					
0304		REPAIR			2.5				
	VALVE, RELIEF	SERVICE		1.0					
	AIR CLEANER (DRY)	INSPECT	0.1						
		SERVICE	0.1						
		REPLACE		1.0					
		REPAIR		1.0					
	FILTER	INSPECT	0.1						
0304		SERVICE	0.3						
		REPLACE		0.2					
	DUCTS	INSPECT		0.3					
		REPLACE		1.0					
		REPAIR		1.5					
	HOSES	INSPECT		0.2					
		REPLACE		1.0					
	MOTOR, DUST EXHAUSTER	TEST		0.2					
		REPLACE		0.5					
		REPAIR			1.5				

0305	BLOWER, INTAKE, ENGINE	INSPECT			0.1						
		REPLACE			0.4						
		REPAIR				2.0					
	SHAFT, BLOWER DRIVE	INSPECT			0.2						
		REPLACE			0.5						
	TURBOCHARGER	INSPECT			0.2						
		REPLACE		0.3							
		REPAIR				8.9					
		OVERHAUL					*				
	DUCT, AIR	INSPECT		0.1							
		REPLACE		0.2							
		REPAIR		0.2							
0306	TANK, FUEL	INSPECT	0.2								
		SERVICE	0.3								
		REPLACE			10.0						
		REPAIR			6.0						
0306	LINES AND FITTINGS	INSPECT	0.3								
		REPLACE		2.0							
	FUEL SYSTEM AIR PURGE PUMP	TEST		0.1							
		REPLACE		2.0							

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category					Tools and Equipment	Remarks
			C	O	F	H	D		
0308	GOVERNOR, ENGINE	INSPECT			0.2				
		TEST			0.1				
		SERVICE			0.1				
		ADJUST			0.2				
		REPLACE			0.3				
		REPAIR			0.3	2.6			
0309	ELEMENT AND GASKET, FUEL STRAINER (PRIMARY)	REPLACE		0.2					
	ELEMENT AND GASKET, FUEL FILTER (SECONDARY)	REPLACE		0.2					
	FILTER, FUEL (PRIMARY AND SECONDARY)	INSPECT	0.1						
		SERVICE	0.2						
		REPLACE		0.3					
0311	HEATER, ENGINE AIR BOX	INSPECT		0.2					
		TEST		0.3					
		REPLACE			2.0				
		REPAIR				3.0			

0312	CONTROLS AND LINKAGE, ACCELERATOR AND THROTTLE	INSPECT	0.2								
		SERVICE		0.2							
		ADJUST		0.2							
		REPLACE		2.0							
		REPAIR		1.0							
04	EXHAUST SYSTEM										
0401	PIPE, EXHAUST	INSPECT	0.2								
		REPLACE		0.5							
05	COOLING SYSTEM										
0501	RADIATOR	INSPECT	0.2								
		SERVICE	0.1						36		
		REPLACE		1.5							
		REPAIR			1.0						
	SURGE TANK	INSPECT	0.2								
		REPLACE		0.3							
		REPAIR			0.5						
0502	SHROUD, RADIATOR	INSPECT	0.2								
		REPLACE		2.2							
		REPAIR			0.5						

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category *					Tools and Equipment	Remarks
			C	O	F	H	D		
0503	MANIFOLD, WATER	INSPECT	0.1						
		REPLACE		0.3					
		REPAIR		0.4					
	THERMOSTATS	INSPECT		0.1					
		REPLACE		0.5				37,38	
0503	HOSES AND PIPES	INSPECT	0.2						
		REPLACE		0.4					
	DETECTOR, AERATION	INSPECT		0.1					
		REPLACE		0.3					
0504	PUMP, COOLANT	INSPECT	0.1						
		REPLACE		1.0					
		REPAIR			1.5				
0505	FAN DRIVE ASSEMBLY	INSPECT			0.2				
		SERVICE	0.1						
		REPLACE			3.5				
		REPAIR			3.0				
	HOUSING, FAN DRIVE	INSPECT	0.1						
		REPLACE			0.3				
		REPAIR			0.3				

		VANE AXIAL FAN ASSEMBLIES (OIL FILLED)	INSPECT	0.2	0.2				
			SERVICE		0.5				
			REPLACE			2.0			46
			REPAIR			1.0		4.0	
	06	ELECTRICAL SYSTEM							
	0601	ALTERNATOR	INSPECT		0.3				
			TEST		0.2				
			REPLACE		1.0				
			REPAIR			0.3			
			OVERHAUL				2.4		
	0602	REGULATOR, VOLTAGE	TEST		1.0				
			ADJUST		1.0				
			REPLACE		0.3				
	0603	STARTER	INSPECT		0.2				
			TEST		0.5				
			REPLACE		1.0				
			REPAIR			2.0			
		RELAY, STARTER PROTECTION	INSPECT	0.1					
			TEST		0.3				
			REPLACE		1.0				

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment	(6) Remarks
		REPAIR			3.0				
0607	INSTRUMENT CONTROL PANELS AND ACCESSORY PANEL ASSEMBLIES	INSPECT	0.1						
		TEST		0.3					
		REPLACE		2.0					
		REPAIR		0.6					
	LIGHT	INSPECT	0.1						
		TEST		0.2					
		REPLACE		0.2					
0607	SWITCHES	INSPECT	0.1						
		TEST		0.2					
		REPLACE		0.5					
	GAGES	INSPECT	0.1						
		TEST		0.3					
		REPLACE		1.0					
0608	RELAY, STARTER	INSPECT		0.1					
		TEST		0.2					

			REPLACE		0.2						
		RELAY, MASTER	INSPECT		0.1						
			TEST		0.2						
			REPLACE		0.2						
		RECTIFIER ASSEMBLY	INSPECT	0.1							
			TEST			0.2			53, 54		
			REPLACE		0.2						
			REPAIR			1.0					
	0609	LIGHTS	INSPECT	0.1							
			TEST		0.2						
			REPLACE		0.2						
			REPAIR		0.2						
	0610	SWITCHES, WARNING	TEST		0.2						
			REPLACE		0.3						
		UNITS, SENDING	INSPECT		0.1						
			TEST		0.2						
			REPLACE		0.5						
	0612	BATTERY, STORAGE	INSPECT	0.1							
			TEST		0.2						
			SERVICE	0.1	0.2						
			REPLACE		1.0						

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment	(6) Remarks
		REPAIR			1.0				
	CABLE, BATTERY	INSPECT	0.1						
		TEST		0.2					
		SERVICE	0.1	0.2					
		REPLACE		0.6					
0613	WIRING HARNESS, HULL								
	ENGINE DISCONNECT BRACKET TO BULKHEAD WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					
		REPLACE			2.0				
		REPAIR		1.5					
	POWER LEAD WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					
		REPLACE			2.0				
		REPAIR		1.5					
	ACCESSORY CONTROL BOX TO HEATER/BLOWER WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					

			REPLACE	2.0							
			REPAIR								
		PORTABLE INSTRUMENT PANEL WIRING HARNESS	INSPECT	0.3							
			TEST	0.5							
			REPLACE	2.0							
			REPAIR	1.5							
		DRIVER'S INSTRUMENT PANEL WIRING HARNESS	INSPECT	0.3							
			TEST	0.5							
			REPLACE	2.0							
			REPAIR	1.5							
		BULKHEAD TO DRIVER'S INSTRUMENT PANEL WIRING HARNESS	INSPECT	0.3							
			TEST	0.5							
			REPLACE		2.0						
			REPAIR		1.5						
		BULKHEAD TO HEADLIGHT/BILGE PUMP WIRING HARNESS	INSPECT	0.3							
			TEST	0.5							
			REPLACE		2.0						
			REPAIR	1.5							

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment	(6) Remarks
	POWERPLANT WIRING HARNESS	INSPECT		0.2					
		TEST		1.0					
		REPLACE		2.0					
		REPAIR		2.0					
	MISC ACCESSORY LEADS AND HARNESSES	INSPECT		0.5					
		TEST		0.5					
		REPLACE		0.5					
		REPAIR		1.0					
	BULKHEAD TO PORTABLE INSTRUMENT PANEL WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					
		REPLACE			2.0				
		REPAIR			1.5				
	RECTIFIER TO VOLTAGE REGULATOR WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					
		REPLACE		2.0					

	REPAIR	1.5	
VENTILATED FACE PIECE SYSTEM POWER HARNESS	INSPECT	0.3	
	TEST	0.5	
	REPLACE	2.0	
	REPAIR	0.5	
AIR CLEANER BLOWER MOTOR RELAY	INSPECT	0.3	
	TEST	0.5	
	REPLACE	2.0	
	REPAIR	0.5	
IN-TANK FUEL PUMP RELAY LEAD ASSEMBLY	INSPECT	0.3	
	TEST	0.5	
	REPLACE	2.0	
	REPAIR	0.5	
STARTER TO ENGINE ELECTRICAL DISCONNECT CABLE ASSEMBLY	INSPECT	0.3	
	TEST	0.5	
	REPLACE	2.0	
	REPAIR	0.5	

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category					Tools and Equipment	Remarks
			C	O	F	H	D		
	EXTERNAL POWER/SLAVE RECEPTACLES	INSPECT	0.2						
		SERVICE	0.1						
		TEST		0.4					
		REPLACE		0.2					
	NATO SLAVE TO EXTERNAL POWER WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					
		REPLACE		2.0					
		REPAIR		0.5					
	ENGINE DISCONNECT BRACKET TO BATTERIES WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					
		REPLACE		2.0					
		REPAIR		0.5					
	DRIVER'S BULKHEAD TO BATTERIES WIRING HARNESS	INSPECT		0.3					
		TEST		0.5					
		REPLACE		2.0					

			REPAIR		0.5							
		DRIVER'S BULKHEAD TO MASTER RELAY WIRING HARNESS	INSPECT		0.3							
			TEST		0.5							
			REPLACE			0.5						
			REPAIR		0.5							
		DIODE HARNESS ASSEMBLY	INSPECT		0.3							
			TEST		0.5							
			REPLACE		2.0							
			REPAIR		0.5							
	0616	BLOWER, VENTILATING	TEST		0.2							
			REPLACE		0.5							
			REPAIR			1.0						
	07	TRANSMISSION										
	0705	CONTROL ASSEMBLY, SHIFTING LINKAGE	INSPECT	0.2								
			SERVICE	0.2								
			ADJUST		0.2							
			REPLACE		3.6							
			REPAIR		2.0							

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category					Tools and Equipment	Remarks
			C	O	F	H	D		
0710	TRANSMISSION ASSEMBLY CROSS-DRIVE	INSPECT	0.2						
		TEST		0.3				2,33	
		SERVICE	0.2						
		ADJUST		0.2				39,40,41	
		REPLACE			5.0			6,7	
		REPAIR			9.0				
		OVERHAUL				46.0	*		
0721	FILTER, OIL	SERVICE		0.1					
		REPLACE		0.1					
08	FINAL DRIVE ASSEMBLY								
0801	POWER TRANSFER ASSEMBLY	INSPECT	0.1						
		REPLACE			1.0				
		REPAIR			2.0				
		OVERHAUL				3.0	*		
	DRIVE ASSEMBLY, FINAL	INSPECT	0.1						

		SERVICE	0.1					
		REPLACE		2.5			1,3,4,5	
		REPAIR		0.5		7.0		
		OVERHAUL				4.0		
12	BRAKES							
1201	PARKING BRAKES	INSPECT	0.1					
		ADJUST		0.2				
		REPLACE		1.5				
		REPAIR		1.0				
1206	MECHANICAL BRAKE SYSTEM, SERVICE BRAKE CONTROLS AND LINKAGE							
		INSPECT	0.2					
		SERVICE	0.2					
		ADJUST		0.5				
		REPLACE		1.0				
		REPAIR		1.0				
13	WHEELS AND TRACKS							
1301	ARM AND HUB ASSEMBLY, ROADWHEEL	INSPECT	0.1					
		SERVICE	0.2					
		REPLACE		1.0				

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category					Tools and Equipment	Remarks
			C	O	F	H	D		
		REPAIR		0.7	2.0			12,17,18,20, 21,22,23	
		OVERHAUL				2.1			
	DISC ASSEMBLY, ROADWHEEL	INSPECT		0.1				11	
		REPLACE		0.5				13	
		REBUILD					*		
	ANCHOR, TORSION BAR	REPLACE		1.0					
	TORSION BAR	INSPECT	0.2						
		REPLACE		1.0				8,14,19	
1303	ARM ASSEMBLY COMPENSATING IDLER	INSPECT	0.1						
		SERVICE	0.2						
		REPLACE		2.0					
		REPAIR		1.7	3.0				
	IDLER WHEEL	INSPECT	0.1						
		REPLACE		1.0					
	LINK COMPENSATING, TRACK ADJUSTING	INSPECT	0.1						
		ADJUST	0.3						

	DISC ASSEMBLY, ROADWHEEL	INSPECT		0.1				11	
		REPLACE		0.5				13	
		REBUILD					**		
	ANCHOR, TORSION BAR	REPLACE		1.0					
	TORSION BAR	INSPECT	0.2						
		REPLACE		1.0				8,14,19	
1303	ARM ASSEMBLY, COMPENSATING IDLER	INSPECT	0.1						
		SERVICE	0.2						
		REPLACE		2.0					
		REPAIR		1.7	3.0				
	IDLER WHEEL	INSPECT	0.1						
		REPLACE		1.0					
	LINK COMPENSATING, TRACK ADJUSTING	INSPECT	0.1						
		ADJUST	0.3						
		REPLACE		1.5					
		REPAIR		1.0					
1304	HUB AND SPROCKETS, DRIVE	INSPECT	0.2						
		REPLACE		2.0					

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category *					Tools and Equipment	Remarks
			C	O	F	H	D		
1305	TRACK ASSEMBLY	INSPECT	1.0						
		ADJUST	1.0						
		REPLACE		4.0				9,10	
		REPAIR		1.5					
	SHOE ASSEMBLY	REPLACE		1.0					
		REPAIR		0.5					
14	STEERING CONTROLS								
1401	STEERING CONTROLS	INSPECT	0.3						
		SERVICE	0.2						
		ADJUST		0.2					
		REPLACE		2.0					
		REPAIR		2.0					
15	FRAME, TOWING ATTACHMENTS, AND DRAWBARS								
1503	PINTLES	INSPECT	0.1						
		SERVICE	0.1						
		REPLACE		0.5					
		REPAIR		0.5					

		REPLACE		1.0	
		REPAIR		1.0	
1803	DRIVER'S HATCH	INSPECT	0.2		
		SERVICE	0.2		
		REPLACE		1.0	
		REPAIR		1.0	
1804	SUBFLOOR DRAINS	SERVICE		0.3	
		INSPECT	0.2		
		REPLACE		0.2	
		REPAIR		0.2	
1806	SEAT ASSEMBLY, DRIVER'S AND CREW	INSPECT	0.1		
		SERVICE	0.2		
		REPLACE		2.0	
		REPAIR		1.5	
1808	STOWAGE BOXES BRACKETS, AND STRAPS	INSPECT	0.5		
		SERVICE	0.2		
		REPLACE		2.0	
		REPAIR		2.5	
20	SPADE				

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Category C	O	F	H	D	(5) Tools and Equipment	(6) Remarks
2005	SPADE AND RELATED PARTS	INSPECT	0.2						
		SERVICE	0.5						
		ADJUST		0.2					
		REPLACE		2.0					
		REPAIR		2.0					
22	BODY, CHASSIS, OR HULL ACCESSORY ITEMS								
2205	BILGE PUMP	INSPECT		0.2					
		REPLACE		0.5					
		REPAIR			1.0				
2207	HEATER, PERSONNEL	INSPECT	0.2						
		TEST		0.2					
		SERVICE		0.2					
		ADJUST		0.2					
		REPLACE		2.0					
		REPAIR			3.5				

2210	DATA PLATES & INSTRUCTION HOLDERS	INSPECT	0.2						
		REPLACE		0.5	0.5				
33	SPECIAL PURPOSE KITS								
3301	REUSABLE SHIPPING CONTAINERS	REPAIR		0.5	0.5		*		
		OVERHAUL					*		
3303	WINTERIZATION KIT	INSPECT		0.2					
		INSTALL			9.0				
		REPAIR			3.0				
3307	AOAP ASSEMBLY	SERVICE	0.3						
		INSTALL	1.0						
47	WEIGHING AND MEASURING DEVICES								
4701	TACHOMETER, SPEEDOMETER AND RELATED PARTS	INSPECT	0.2						
		TEST		0.5					
		SERVICE		0.5					
		REPLACE		1.0					
		REPAIR		1.0					

(1)	(2)	(3)	(4)					(5)	(6)
Group Number	Component/Assembly	Maintenance Function	Maintenance Category					Tools and Equipment	Remarks
			C	O	F	H	D		
4702	GAGES MOUNTINGS, LINES & FITTINGS	INSPECT	0.1						
		REPLACE		0.5					
		REPAIR		0.5					
76	FIRE FIGHTING EQUIPMENT COMPONENTS								
7639	CONTROLS	INSPECT	0.2						
		REPLACE		1.0					
91	NUCLEAR, BIOLOGICAL AND CHEMICAL WARFARE EQUIPMENT								
9110	NBC HOSES AND CONNECTORS	INSPECT	0.2						
		REPLACE		0.3					
	NBC HEATER	INSPECT	0.1						
		TEST		0.2					
		REPLACE		1.0					
		REPAIR		0.1					
9111	AIR PURIFIER	TEST		0.3					
		REPLACE		1.0					
		REPAIR		1.0	3.0				

		REPAIR		1.0							
	CYLINDER ASSEMBLY, FIXED	INSPECT	0.1								
		SERVICE			1.0						
		REPLACE		1.0							
	LINES AND TUBES	INSPECT		0.3							
		REPLACE		1.0							
		REPAIR		1.0							

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL AND TEST EQUIPMENT REQUIREMENTS				
Tool or Test Equipment Number Reference Code	Maintenance Category	Nomenclature	National/NATO Stock Number	Tool
		TRANSMISSION		
1	O	BOLT, EYE: Used with sling, 5120-00-034-0875 to remove or install final drive assembly	5306-00-050-0347	MS51937-5 (96906)
2	O	GAGE, PRESSURE, DIAL INDICATING: To check engine and transmission oil pressure	4910-00-572-8612	8356176
3	O	PIN, GUIDE: To install final drive assembly	5120-00-034-0883	10914195
4	O	WRENCH, STRAP: To aline transmission output shaft and final drive input shaft	5120-00-357-9154	7676003 41-W-3382
5	O	SLING, LIFTING, FINAL DRIVE: Used with eye bolt, 5306-00-050-0347 to remove or install final drive assembly	5120-00-034-0875	10914179
6	F	SLING, TRANSMISSION LIFTING: Used with bracket 4910-00-977-5580 to lift transmission after separation of engine and transmission	4910-00-473-7556	7081593
7	F	BRACKET, LIFTING: Used with sling, 4910-00-473-7556 to lift transmission after separation of engine and transmission	4910-00-977-5580	8355697

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		SUSPENSION		
8	0	ADAPTER, MECHANICAL PULLER: Used with puller, 5120-00-557-3615 to remove or install torsion bars	5120-00-322-5953	708370
9	C,0	FIXTURE, TRACK CONNECTING: To disconnect or connect track (with bar)	5120-00-605-3926	8741739
10	0	PULLER, END CONNECTOR, TRACK: To remove double pin track end connector	5120-01-051-4150	11669394-2
11	0	GAGE AND CASE ASSEMBLY: Roadwheel wear plate	4910-00-034-0874	10911904
12	F	REPLACER: Upper spindle arm retainer oil seal; used with 10914196	5120-00-034-0881	10914188
13	0	LIFTER, ROADWHEEL: To raise roadwheel	4910-00-912-4469	11593605
14	0	PULLER, SLIDE HAMMERTYPE: Used with adapter, 5120-00-322-5953 to remove or install torsion bar	5120-00-557-3615	5573615
15	0	REMOVE AND REPLACER: To remove and replace shock absorber bearing	5120-00-084-7627	C-DTA-94390 10925993
16	0	PULLER, SHOCK ABSORBER: To remove shock absorber	5120-00-084-7626	10913972
17	0	REPLACER, BEARING CUP: Used with handle, 5120-00-034-0884 to replace roadwheel hub inner bearing cup	5120-00-034-0880	10914187

III. TOOL AND TEST EQUIPMENT REQUIREMENTS - continued

TOOL AND TEST EQUIPMENT REQUIREMENTS				
Tool or Test Equipment Number Reference Code	Maintenance Category	Nomenclature	National/NATO Stock Number	Tool
18	O,F	REPLACER, BEARING CUP: Used with handle, 5120-00-034-0884 to replace roadwheel hub outer bearing cup	5120-00-034-0885	10914197
19	O	WRENCH, TORSION BAR RETAINING NUT: To remove or install torsion bar retaining nut	5120-00-708-3642	7083642
20	O,F	HANDLE, REPLACER: Used with bearing cup and oil seal replacers	5120-00-034-0884	10914196
21	O,F	REPLACER: Wheel hub inner oil seal; used with 10914196	5120-00-034-0879	10914186
22	F	WRENCH, PRONG: Used on spindle arm support bearing adjusting nut	5120-00-034-0867	10914193
23	F	REPLACER: Upper spindle arm support housing oil seal; used with 10914196 handle	5120-00-034-0878	10914185
		POWERPLANT		
24	O,F	ADAPTER, STRAIGHT PIPE-TO-TUBE: Used with hose assembly, 4720-00-080-8586 to operate powerplant out of vehicle	4730-00-921-3242	MS39158-7 (96906)
25	O,F	LEAD, ELECTRICAL, ENGINE STARTER: Starter power to operate powerplant out of vehicle	4910-00-084-0793	10914183

	26	0,F	CABLE ASSEMBLY, GROUND: Powerplant-to-vehicle ground to operate power-plant out of vehicle	4910-00-084-0789	10913655
▌	26.1	0,F	CABLE ASSEMBLY, POWER ELECTRICAL STARTER CIRCUIT: To operate power plant out of vehicle.		12268427
	27	0,F	CABLE ASSEMBLY, POWER ELECTRICAL: Rectifier-to-alternator to operate powerplant out of vehicle	4910-00-930-8764	11605054
▌	27.1	0,F	CABLE ASSEMBLY, POWER ELECTRICAL: Rectifier to alternator to operate powerplant out of vehicle		12268426
	28	0,F	CABLE ASSEMBLY, POWER ELECTRICAL STARTER & MASTER WARNING CIRCUIT: To operate powerpack out of vehicle	2590-01-115-2276	12268162
	29	0,F	COUPLING ASSEMBLY, QUICK-DISCONNECT: Used with hose assembly, 4720-00-080-8588 to operate powerplant out of vehicle	4730-00-738-8571	7388571
	30	0,F	HOSE ASSEMBLY, NONMETALLIC: Used for fuel supply and fuel return to operate powerplant out of vehicle	4720-00-080-8586	8708306
	31	0,F	SCREEN, SAFETY: Turbocharger inlet to operate powerplant out of vehicle	4910-00-981-2766	10913779
	32	0	SLING, LIFTING, POWERPLANT: To remove or install powerplant assembly	4910-00-295-8074	11652649
	33	0,F	STALL CHECK KIT: To stall check engine and/or transmission (power-plant removed from vehicle).	4910-00-757-1962	8351309

SECTION III. TOOL AND TEST EQUIPMENT REQUIREMENTS - Continued

TOOL AND TEST EQUIPMENT REQUIREMENTS				
TOOL OR TEST EQUIPMENT NUMBER REFERENCE CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL
34	0	WRENCH, BOX SPECIAL: To remove or install powerplant mount support	5120-00-051-5567	11605662
35	F	SLING, MULTIPLE LEG: Used for lifting engine during and after separation of engine and transmission	4910-00-977-7398	10930560
		MISCELLANEOUS		
36	C,0	CLEANING TOOL, RADIATOR: To remove sand, oil, and other debris from radiator cooler fins	2815-00-494-8257	11641959
37	0	HANDLE, INSTALLER: Used with installer, 5120-00-977-5579 to install thermostat housing seal	5120-00-977-5578	KM-J-7079-2 (33287)
38	0	INSTALLER, SEAL: Used with handle, 5120-00-977-5578 to install thermostat housing seal	5120-00-977-5579	KM-J-8550 (33887)
39	0	WRENCH, SPLINED BRAKE ADJUSTMENT: To check right brake adjustment	5120-00-733-8909	8351386
40	0	WRENCH, SPLINED BRAKE ADJUSTMENT: To check left brake adjustment	5120-00-733-8912	8351387
41	0	GAGE: Brake adjusting	5120-00-733-5005	8351213 (19207)

42	O	OPTICAL BATTERY/ANTIFREEZE TESTER: To check specific gravity of electrolyte in batteries and engine coolant	6630-00-105-1418	VUCHEK
43	O	GAGE, SPROCKET WEAR: To check sprocket wear	4910-00-842-3051	11631464
44	F, H	FINAL DRIVE WORK STAND: Allow for torquing of final drive assembly nut		
45	F, H	SOCKET: Used to torque final drive assembly nut	5130-00-076-8631	55719 IM 1123
46	F, H	SOCKET: Used to remove and install fan impeller nut	5120-01-255-8232	12268253
47	F, H	ENGINE STAND: Used to support engine after separation from transmission and transfer case	4910-00-795-0189	7950189
48	F, H	CRADLE ASSEMBLY	4910-00-795-0198	7950198
49	F, H	ENGINE MOUNTING BRACKET	4910-00-737-0432	10903999
50	F, H	DRIP PAN	4930-00-545-8639	8708359
51	O	TESTER, AIRFLOW: Tests gas particulate filter unit	6680-00-436-4212	E5-77-2120
52	O	HOSE: Three foot length. Used to test operation of left and right in-tank fuel pumps.	4720-01-081-2764	MS28759-G-0330
53	O	Automotive Maintenance Common No. 1 Tool Kit	4910-00-754-0654	SC 4910-95-CL A74
54	O	Automotive Maintenance Common No. 2 Tool Kit	4910-00-754-0650	SC 4910-95-CL A72

APPENDIX C
EXPENDABLE SUPPLIES AND MATERIALS LIST

SECTION I. INTRODUCTION

C-1. SCOPE.

This appendix lists expendable supplies and materials you will need to operate and maintain the M109A2/M109A3 or M109A4 vehicle. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

C-2. EXPLANATION OF COLUMNS.

a. Column 1 - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Use cleaning compound, item 5, App. D").

b. Column 2 - Level. This column identifies the lowest level of maintenance that requires the listed items:

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. Column 3 - National Stock Number. This is the National stock number assigned to the item; use it to request or requisition the item.

d. Column 4 - Description. Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by the Federal Supply Code for Manufacturer (FSCM) in parentheses, if applicable.

e. Column 5 - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea. in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

SECTION II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1		8040-00-262-9025	ADHESIVE: MIL-A-5092 Type I (81349)	OZ
2		8040-00-262-9026	ADHESIVE: MIL-A-5092 Type I (81349)	PT
3			ADHESIVE: MM-A-5, Type II (81349)	
4			ADHESIVE: MM-A-1617 Type II (81349)	
5		8040-00-165-8614	ADHESIVE: MMM-A-121 (81348)	QT
6		8040-00-273-8717	ADHESIVE: MMM-A-121 (81348)	PT
7		6850-00-181-7929	ANTIFREEZE, PERM O-A-548, 1 GAL CAN MIL-A-46153 (81349)	GL
8		6850-00-181-7933	ANTIFREEZE, PERM O-A-548, 1 GAL. CAN MIL-A-46153 (81349)	GL
9		6850-00-174-1806	ANTIFREEZE, ARCTIC TYPE 55 GAL. DRUM MIL-A-11755 (81349)	DR
10		3105-00-269-4662	BAG, PLASTIC: MIL-B-117 (81349)	EA
11		6850-00-598-7328	CLEANING COMPOUND, 2 CCMP CAN MIL-C-10597 (81349)	KT

12		6850-00-227-1887	CLEANING COMPOUND MIL-C-43454 (81349)	QT
13		6850-00-224-665	CLEANING COMPOUND MIL-C-11090 (81349)	CN
14		6850-00-224-6657	CLEANING COMPOUND, RIFLE MIL-C-372 (81349)	CN
15		6850-00-224-6663	CLEANING COMPOUND, RIFLE MIL-C-372 (81349)	GL
16		5350-00-221-0872	CLOTH, ABRASIVE CROCUS .50 SHEETS PC458 (81348)	PG
17		6850-00-901-0591	DEICING-DEFROSTING COMPOUND 5 GAL. CAN MIL-A-8243 (81349)	CN
18		6850-00-281-1985	DRYCLEANING SOLVENT P-S-661 (02978)	GL
19		6850-00-281-3061	DRYCLEANING SOLVENT, 4 OZ. CAN P-D-680 (81348)	DR
20		8010-00-527-2050	ENAMEL, GLOSS, BLACK 1 GAL. CAN TTE489 CLASS A (81348)	PT
21		8010-00-527-2053	ENAMEL, GLOSS, BLACK 1 QT CAN TTE489 CLASS A (81348)	QT
22		8010-00-297-2105	ENAMEL, SEMIGLOSS, OLIVE DRAB TTE485 (81348)	GL
23		8010-00-297-2109	ENAMEL, SEMIGLOSS, OLIVE DRAB TTE485 Type 2 (81348)	PT
24		8010-00-664-7653	ENAMEL, SYN, GLOSS, WHITE TTE489 (81349)	QT
25		9110-00-391-7813	FUEL, JELLIED, ALCOHOL 2.625 OZ CAN 4006 (94745)	CN

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST - CONTINUED

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
26		9150-00-935-1017	GREASE, AUTOMOTIVE ART, 14 OZ CAN MIL-G-10924 (81349)	TY
27		9150-00-190-0904	GREASE, AUTOMOTIVE ART MIL-G-10924 BRAYCOTE610 (98308)	LB
28		9150-00-190-0905	GREASE, AUTOMOTIVE ART MIL-G-10924 BRAYCOTE610 (98308)	LB
29		9150-00-935-9808	HYDRAULIC FLUID, PET, OHT, MIL-H-083 BRAYCO783C (98308)	GL
30		9150-00-935-9807	HYDRAULIC FLUID, PET, OHT, MIL-H-083 BRAYCO783C (98308)	QT
31		6850-00-753-4967	INHIBITOR, CORROSION O-1-00490B (81348)	OZ
32		9150-00-231-6689	LUBRICATING OIL, GEN, PL, SPC VVL800 (81348)	QT
33		9150-00-189-6727	LUBRICATING OIL: MIL-L-2104B (81349)	QT
34		9150-00-188-9858	LUBRICATING OIL: MIL-L-2104B (81349)	CN

35		9150-00-186-6668	LUBRICATING OIL ENG: MIL-L-2104B (81349)	CN
36		9150-00-186-6681	LUBRICATING OIL ENG: MIL-L-2104B (81349)	QT
37		9150-00-231-9062	LUBRICATING OIL, GEN, 5 GAL. CAN VVL800 (81348)	GL
38		9150-00-231-2361	LUBRICATING OIL, GEN. MIL-L-3150 (81349)	QT
39		9150-00-231-2356	LUBRICATING OIL, GEN. MIL-L-3150 (81349)	CN
40		9150-00-402-2372	LUBRICATING OIL, OES, 5 GAL. CAN CONOCODN600 FLUID Type 1 (15445)	
41		9150-00-402-4478	LUBRICATION OIL, OES, 1 QT CAN CONOCODN600 FLUID (15445)	QT
42		6640-00-285-4694	PAPER, LENS NNNP40 (81348)	HD
43		9150-00-250-0926	PETROLATUM, TECHNICAL: VVP236 (81348)	LB
44		9150-00-250-0933	PETROLATUM, TECHNICAL, 5 LB CAN VVP236 (81348)	LB
45		7920-00-205-1711	RAG, WIPING: DD-R-30 (81348)	
46			SEALING, COMPOUND: MIL-S-22473 (81349)	
47		8030-00-159-8176	SEALING, COMPOUND MIL-S-45180 (81349)	TU

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST - CONTINUED

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
48		8030-00-252-3391	SEALING, COMPOUND AGASKETNO2 (77247)	OZ
49		8030-00-765-4507	SEALING, COMPOUND: MIL-S-11030 (81349)	FT
50			TAPE: MM-T-595 (81349)	
51		8010-00-242-2089	THINNER, PAINT MIXER TTT291GR1 - 1GLON (81348)	GL
52		8010-00-558-7026	THINNER, PAINT MINERAL TT-T-291 (81348)	CN
53		5610-00-141-7838	WALKWAY COMPOUND 1 GAL. CAN MIL-W-5044 Type 2 (81349)	GL
54			ZINC CHROMATE, PASTE: TT-P-1757 (81349)	
55			ADHESIVE: MIL-A-46091	
56			PRIMER TT-P-1757	
57		9150-00-935-4071	GREASE, AIRCRAFT AND INSTRUMENT 14 OZ, CARTRIDGE MIL-G-23827	OZ

	58		9150-01-152-4117	OIL, MULTIGRADE 1 QT MIL-L-2104	QT
	59		9150-01-152-4118	OIL, MULTIGRADE 5 GAL. MIL-L-2104	GL
	60		9150-01-152-4119	OIL, MULTIGRADE 55 GAL. MIL-L-2104	GL
	61		9150-00-702-7100	NYLUBE 150 (07161)	QT
	62		6850-01-137-8525	SILICONE HEAT SINK COMPOUND 2 OZ JR MIL-C-47113 (81349)	OZ
	63		8030-00-753-4953	ANTI-SEIZE COMPOUND 1 LB CAN MIL-A-13881	LB
	64		8040-00-701-9616	ADHESIVE SEALANT MIL-A-46106	CN
	65		9150-00-119-9291	GREASE MIL-G-4343	TB
	66		7930-00-525-2477	CLEANING COMPOUND, DETERGENT 1 GAL. P-D-223C	GL
	67		8040-00-285-1104	ADHESIVE MIL-A-5092 TYPE II (81349)	PT

APPENDIX D

STE/ICE PROCEDURES (SIMPLIFIED TEST EQUIPMENT FOR INTERNAL COMBUSTION ENGINES)

SECTION I. INTRODUCTION

D-1. GENERAL

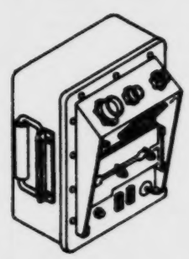
STE/ICE, a testing system for internal combustion engines, provides measurements on voltage resistance, pressure, temperature and speed to analyze the condition of an engine system.

This appendix provides a general overview of STE/ICE equipment and operations, along with specific procedures in diagnosing and isolating malfunctions of the M109A2/M109A3 and M019A4 engines.

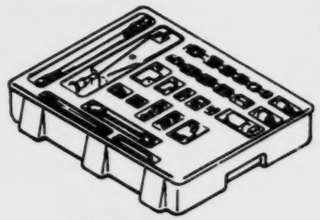
STE/ICE will also provide a thorough preventative maintenance check on M109A2/M109A3 and M109A4 engines as part of service upon receipt and as an annual check in the PMCS.

D-2. DESCRIPTION OF STE/ICE EQUIPMENT

The STE/ICE set consists of a vehicle test meter (VTM), five cable assemblies, transducer kit (TK), manual and transit case.

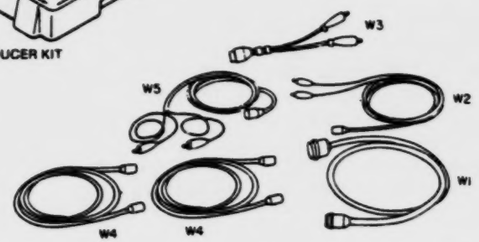


VEHICLE TEST METER

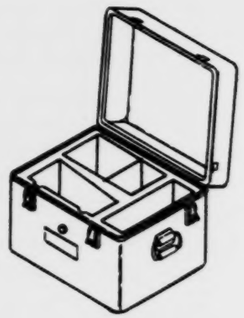


TRANSDUCER KIT

TECHNICAL MANUAL

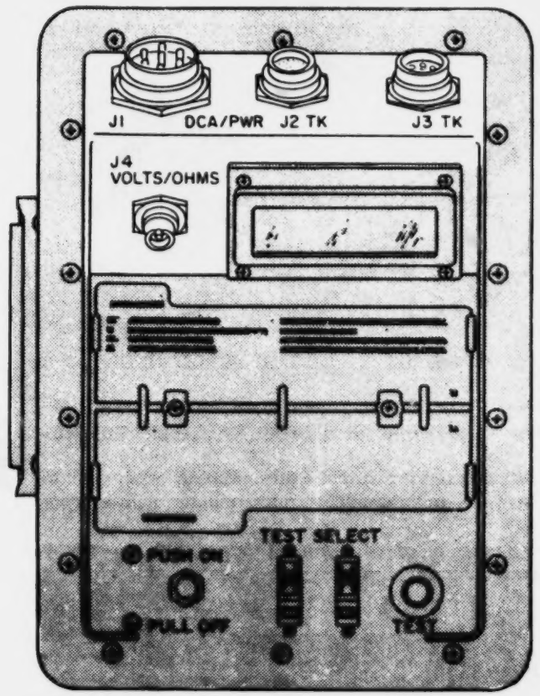


CABLE ASSEMBLIES



TRANSIT CASE

a. Vehicle test meter (VTM). The VTM is the diagnostic meter of STE/ICE used for testing electrical and mechanical components of the M109 system. The VTM consists of 3 switches, a readout display, flip cards and 4 cable connectors.



(1) Switches. The three switches are a PUSH ON/PULL OFF switch, TEST SELECT switch and TEST button. The PUSH ON/PULL OFF switch is used to control power to the VTM from the power source. The TEST SELECT switch are two ten-position switches used to select the test to be performed. The TEST button has two functions: (1) when pressed and rebased it initiates selected test; (2) pressed and held it initiates an offset test.

(2) Readout display. The readout display gives five different types of messages during testing and up to a maximum of four characters per message. The types of messages are:

- error
- status
- numerical
- prompting
- confidence test error

Readout display messages can be found in paragraph D-3, page D-6.

(3) Flip cards. The flip cards, attached to the front of the VTM, provide a quick but limited reference for the operator. These flip cards list test numbers, messages and some procedures. Test limits are also provided for some vehicles.

(4) Cable connectors. The four cable connectors on the VTM are DCA/PWR J1, transducer cable connectors J2TK and J3TK and VOLTS/OHMS J4.

. DCA/PWR connector J1 - used to connect the VTM to a DC power source with the power cable W5 (see p. D-5). The DC power source is usually the vehicles batteries.

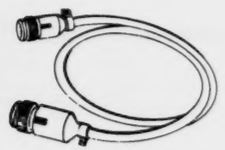
. Transducer cable connectors J2TK and J3TK - used to connect transducer cables W4 to VTM. Power and signals are routed through these connectors. Both connectors may be used when a test requires two measurements to be made at the same time.

. VOLTS/OHMS connector J4 - used to connect test probe cable W2 to VTM for voltage and resistance tests.

b. Cable assemblies. In procedures in this manual, the cable assemblies are referred to by a number for quick identification. Each cable also has a name which describes its use. A reference to W1, for example, would indicate the DCA cable. Connectors on the cable are identified by a number preceeded by either a P or an E, such as P1 or E2.

The cable assemblies included in the STE/ICE are:

. W1 - DCA cable
. W2 - test probe cable
. W3 - ignition adapter cable
. W4 - transducer cable (two)
. W5 - power cable



W1

W2

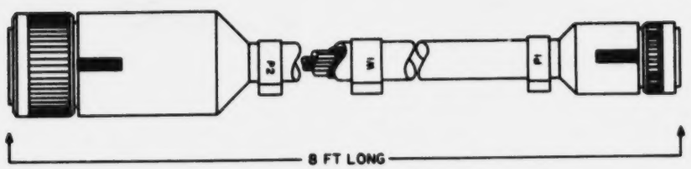
W3

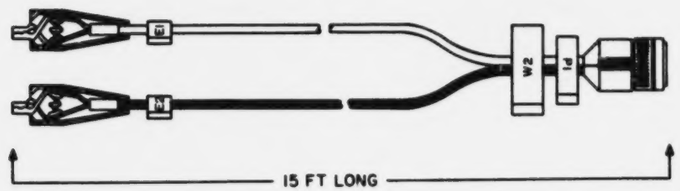
W4

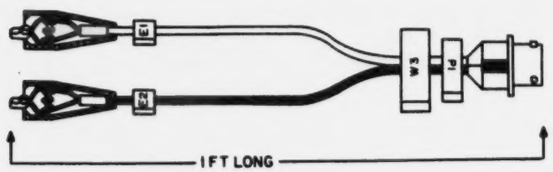
W4

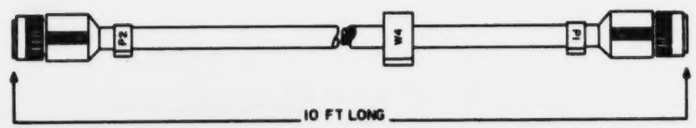
W5

b. Cable assemblies - continued









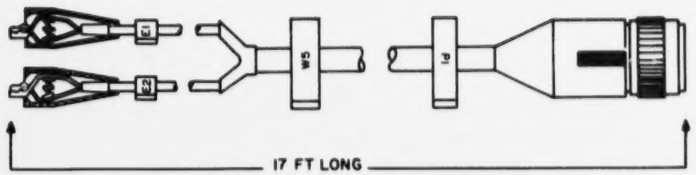
When cables are connected, the large key (1) located by the white stripe (2) on the cable connector mates with large keyway (3) of connector on VTM or transducer.

(1) Diagnostic Connector Assembly Cable W1. The W1 is used to power the VTM and provide access to test points and sensors connected to vehicle/equipment mounted DCA. There is no DCA capabilities in the M109A2/A3 or M109A4 presently.

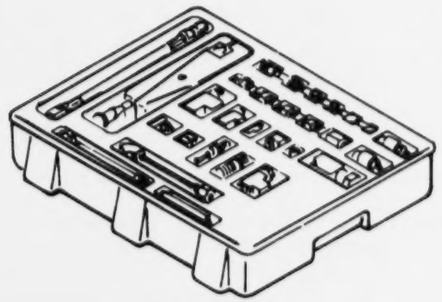
(2) Test probe cable W2. The test probe cable for both general and special measurements. It is used for measuring voltages, frequency, resistance and continuity, and also for the first peak series and compression unbalance tests. W2 is divided into two color coded leads, red for E1 and black for E2. Test clips E1 and E2 of W2 attach to points on the veh/equipment being tested.

(3) Ignition adapter cable W3. The ignition adapter cable W3 is used in measuring dwell angle, points voltage, engine rpm and power tests. W3 is divided into two color coded leads, red for E1 and black for E2.

(4) Transducer cables W4. The transducer cables W4 are used as extensions to connect the VTM to a pressure transducer, pulse tachometer, current probe or ignition adapter cable. If necessary two transducer cables can be joined using connector adapter, TK item 29.



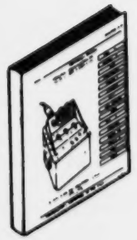
(5) Power cable W5. The power cable W5 is used to power the VTM when cable W1 is not being used. Cable W5 is divided into two leads with color coded clips, red for E1 and black for E2. Battery clips E1 and E2 are attached to a vehicle/equipment battery or a 9 to 32 volt 4A regulated power supply. Do not connect the VTM to a battery charger unless it is also connected to a battery. Damage to the VTM may result.



TRANSDUCER KIT

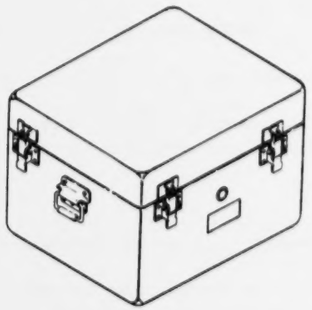
c. Transducer kit (TK). The transducer kit (TK) is a tray inside the transit case that contains transducers, adapters and fittings. The TK is stored in a molded tray in the top of the transit case. The TK item numbers shown in the illustration are for reference only and do not appear on the tray.

Many of the fittings do not have part number markings on them and are referred to by TK Item Number and name. Each fitting is identified by TK item number and part number.



TECHNICAL MANUAL

d. Manual. TM 9-4910-571-12&P contains operating instructions, operator and organizational maintenance instructions, and repair parts and special tools information.



TRANSIT CASE

e. Transit case. The STE/ICE is housed in a portable protective transit case which contains all necessary accessories and instructions.

A pressure relief valve located on the front of the case allows the operator to release any pressure or vacuum resulting from changes in climate during transit.

D-3. READOUT DISPLAY MESSAGES

a. Error messages. Error messages indicate the VTM needs additional or corrected information before testing can continue, or additional procedures are required.

All error messages are displayed as an E followed by three numbers (for example, E003).

Error	Meaning
E000	VTM has been asked for information that it does not have. For example, you have requested the vehicle/equipment ID and it has not been entered.
E001	A test number which does not exist has been entered on the TEST SELECT switches.
E002	The required transducer is not connected.
E003	Test number wrong for DCA connected. This can occur if test selected does not apply to the class of vehicle/equipment under test or if the DCA harness does not have the required transducers.
E004	A vehicle identification number or number-of-cylinders information has not been entered. It can also occur if a VID has been entered that the VTM has not been programmed to recognize.
E005	Required offset test was not performed.
E007	The VID number and number-of-cylinders information entered do not agree.
E008	VTM is not receiving required voltage signal for selected test. This message can occur on tests 14, 15, 19, 20 and 72 through 79.
E009	VTM is not receiving engine speed signal. This applies only to engine power test and SI full power simulation.
E010	A wrong VID number was entered. The VTM will only accept numbers between 01 and 28. If E010 is displayed when the VID entered was between 01 and 28, it means that the VID does not agree with the identity of the DCA harness powering the VTM. The VTM will accept this, allowing you to power through the DCA while testing another vehicle.

Error	Meaning
E011	Throttle control was operated incorrectly. It was taking too long to accelerate or decelerate during power test.
E012	The SI ignition adapter, TK item 30, or CI pulse tachometer, TK item 34, is missing or not connected to the VTM. This message will also occur if a test is valid for SI engines only and the pulse tachometer is attached in place of cable W3.
E013	VTM unable to interpret data received. Rerun test one time.
E014	The wrong number of cylinders was entered. A test that requires a number-of-cylinders entry will only work with 04, 06 or 08.
E017	VTM not receiving ignition system switching signal. This indicates that the engine is not running or that the ignition adapter is broken or not properly connected. Dwell test cannot be performed.
E018	Test discontinued due to no signal being detected by VTM. This indicates that an engine RPM or AC frequency test was terminated automatically to protect the VTM. This will occur after several minutes of no-signal operation.

b. Status messages. Status messages keep the operator informed of what is happening.

Status	Meaning
.8.8.8.8	There is power to the VTM and the display is working properly. This appears only for a short period after power is turned on.
.9.9.9.9	VTM is reading a test value beyond its range.
PASS	Unit under test has passed test, or VTM has accepted a control function entry.
FAIL	Unit under test has failed test.
AUE	Numerical display is an average value.
LO	Engine speed below 1600 RPM during SI power test. Indicates the engine failed the power test.
-1-1-1-1	VTM is busy.

c. Numerical readouts. Numerical Readouts indicates the measured valve in units of the measurement being made. For example, if you are measuring 0-45 volts dc, 12.7 is volts dc. If you are measuring 0-25 psig pressure 12.7 is psig. The units for each test are listed on the flip cards. Also the readout when indulating vehicle identification data (VID).

d. Prompting messages. Prompting Messages indicate the operator must do something. After the operator action is completed, testing will continue.

Action	Meaning
UEH	Tells the operator to enter VID on the TEST SELECT switches.
CYL	Tells the operator to enter the number-of-cylinders into the VTM.
GO	Tells the operator to crank engine.
SIP	Tells the operator to apply full throttle in a S1 power test.

SECTION II. ENGINE TESTING

D-4. GENERAL

There are two different test methods involving the use of STE/ICE equipment. The preventative maintenance checks and services (PMCS) test method uses STE/ICE to check the general condition of the howitzer engine. The STE/ICE engine troubleshooting method isolates a malfunction down to the defective part or assembly.

D-5. PMCS TEST METHOD

The PMCS test method consists of a pre-test inspection and STE/ICE testing.

a. Pre-test inspections. Before using STE/ICE to test the vehicles, perform the following pre-test inspections:

(1) Fan Belts. Check for proper tension. Replace if cracked or frayed.

(2) Ignition Cables. Make sure they are securely connected and in good condition.

(3) Oil Level. Bring up to proper level if low.

(4) Fuel Level. Check that the fuel tank has enough fuel for testing.

(5) Radiator. Bring up to proper level if low.

(6) Battery. Replace the battery if the case is cracked or the terminal posts are damaged. Clean off all corrosion. Check that the battery connections to ground and to starter motor are in good condition, securely connected, and clean. Check the electrolyte level. If low, bring up to proper level with distilled water.

b. STE/ICE testing procedure. PMCS STE/ICE testing procedure consists of two different sequences of tests; GO and NO-GO CHAINS. A GO CHAIN is a logical sequence of tests performed to determine the general condition of the M109 engine. GO CHAINS are arranged so testing starts with GO-1 and proceeds through each GO CHAIN sequence until terminated. Termination will result from a pass or failure. If testing is terminated by the last GO CHAIN test, then the vehicle has no identifiable problems. If testing is terminated by a failed test, then the user will be directed to a specific NO-GO CHAIN where testing is to continue. The NO-GO CHAIN contains procedures to determine the cause of failure of a GO CHAIN test.

The rules to be followed when using the PMCS test method are as follows:

(1) Always start at GO-1. Never enter in the middle of any GO or NO-GO CHAIN.

(2) Follow each instruction in a GO CHAIN. Do not skip any instructions or procedures.

(3) If a particular GO CHAIN fails a test, proceed to the indicated NO-GO CHAIN or to a higher level of maintenance.

(4) After correcting a problem with a NO-GO CHAIN, return to GO-1 to restart testing. This will assure that there are no other problems with the vehicle.

(5) Each GO CHAIN test depends on the successful completion of the previous test. Do not skip any test under any circumstance.

c. Vehicle test card (VTC). Once familiar with STE/ICE testing procedures the vehicle test card (located on page D-12) can be used as a quick reference.

The front of the test card contains all of the information, in abbreviated format, that the user will need to perform common measurements on the vehicle. The organization from the top of the card to the bottom represents a logical order of steps from powering up the VTM to completing a series of tests.

The top of the card describes the power up sequence of STE/ICE for the vehicle. Next, a table is provided which lists many measurements that are useful in troubleshooting the vehicle. The table includes: the associated VTM test number, any required offset test limits, operating condition of the engine, special connections required, the expected limits for pass or fail, and the units of measurement. Also included on the front of the card are hookup diagrams.

The organization of the table allows measurements with the vehicle engine turned off to be performed first. These measurements will insure that the starting system of the vehicle is in working order before proceeding. The order of the other measurements is as follows:

- o Measurements with the engine running but not warm
- o Measurements requiring the engine to be warm and running
- o Measurements requiring the engine to be warm and not running
- o Miscellaneous measurements

The back of the VTC contains the hookups for measurements used to troubleshoot vehicle components. Measurements that require special hookups are also included on this side of the VTC.

To start the PMCS test method, first perform the pre-test inspections and then the GO-1 CHAIN on page D-14.

D-6. STE/ICE ENGINE TROUBLESHOOTING METHOD

The STE/ICE engine troubleshooting method uses only the NO-GO chains. When a malfunction in the engine is recognized by the mechanic, the "Quick Guide to Troubleshooting" will provide a reference to a specific NO-GO CHAIN to isolate the cause of the malfunction.

To start the STE/ICE engine troubleshooting method do the following:

a. Perform GO-1 CHAIN. First, Perform GO-1 CHAIN to set up STE/ICE and check to see if it is in working order.

b. Perform NO-GO CHAIN. Now that STE/ICE is hooked up properly and checks out, perform the NO-GO CHAIN cited in the "Quick Guide to Troubleshooting".

The rules to follow when using STE/ICE engine troubleshooting method are:

(1) Never enter in the middle of a NO-GO CHAIN.

(2) Follow each instruction in a GO CHAIN. Do not skip any instructions or procedures.

(3) After correcting a problem with a NO-GO CHAIN, test run the component, engine or powerplant to insure the problem does not still exist.

D-7. GO CHAINS AND NO GO CHAINS

a. GO CHAINS. GO CHAINS are shown in Figure 1, Sheets 2 through 22.

b. NO-GO CHAINS. NO-GO CHAINS are shown in Figure 2, Sheets 1 through 32.

M109 VEHICLE TEST CARD - VID 11

PRE-TEST INSPECTION

1. Oil level
2. Coolant level
3. Fuel level
4. Batteries

POWERING UP VTM

1. Connect VTM to W5 cable. W5 cable attaches to batteries as shown in figure 2
2. Perform confidence test, test 66 (second entry 99)
3. Enter VID into VTM using test 60

MEASUREMENT NAME	VTM TEST NOS.	VTM OFFSET LIMITS	OPERATING CONDITION	SPECIAL CONNECTIONS REQUIRED	LIMITS MIN	LIMITS MAX	UNITS
Battery Voltage	67	—	Engine off		22	—	Volts
Current First Peak	72	±225	Crank on GO	Current probe — figure 2	875	1680	Amps
Vehicle Gage Oil pressure	—	—	Idle-use test 10 to check idle speed	Pulse tachometer — figure 1	5	—	PSI
Charging Voltage	01.67	—	Lights & accessories on 1000-1200 RPM	Pulse tachometer — figure 1	27.5	28.5	Volts
Vehicle Gage Coolant Temp	—	—	Warm engine		170	185	°F
Vehicle Gage Oil Pressure	—	—	At 1000 RPM — use test 10	Pulse tachometer — figure 1	30	50	PSI
Engine RPM (Average)	10	—	Governor	Pulse tachometer — figure 1	2350	2500	RPM
*Power	13	—	Engine warm	Pulse tachometer — figure 1	75		%
Engine RPM (Average)	10	—	Idle	Pulse tachometer — figure 1	550	600	RPM
Compression Unbalance	14	—	Warm Engine — Crank on GO		—	10	%
Cranking RPM	10	—	Cranking	Pulse tachometer — figure 1	100	—	RPM
Cranking Voltage	67	—	Cranking		18	—	Volts
Cranking Current	90	±225	Cranking	Current probe — figure 2	350	550	Amps
Battery Pack Internal Resistance	73	±225	Crank on GO	Current probe — figure 2	—	13	Milliohms
Starter Circuit Resistance	74	±225	Crank on GO	Current probe — figure 2	3	25	Milliohms
Battery Pack Resistance Change	75	±225	Crank on Go	Current probe — figure 2	—	50	Milliohms/sec

Test limits given are advisory only and are not necessarily the same as vehicle TM's specifications. If test limits are different, use vehicle TM's specifications.

* If vehicle has a turbocharger or fuel limiter, go to vehicle TM for procedure to do power test

FIGURE 1

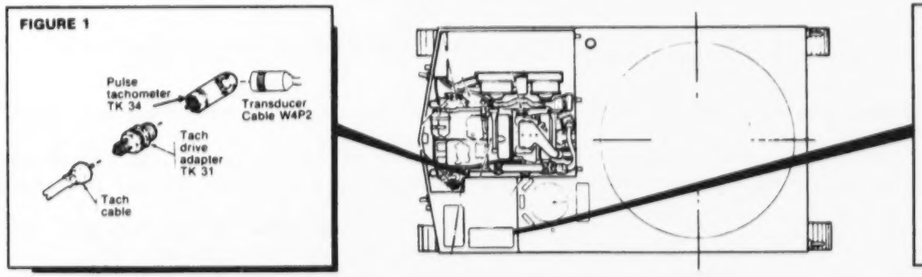


FIGURE 2 (Current probe to starter) Current probe TK 11 & TK Cable W4

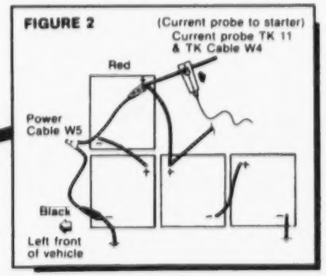


FIGURE 1. SHEET 1a OF 22

M109 VEHICLE TEST CARD - VID 11 Additional Test Connections

ALTERNATOR TESTS

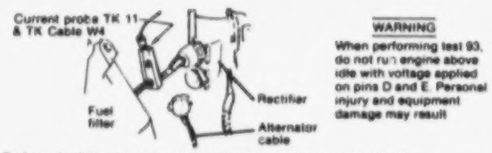
Note: Picture shows conduction -cooled rectifier. Tests also apply to alternator cable in vehicles with fan-cooled rectifier.

Note: Perform the following tests with the alternator cable disconnected as shown.

Test 91, stator resistance measured from pin A to B, B to C, and A to C of alternator cable must be less than 5 ohms with engine off.

Test 92, stator insulation measured from pin A to ground, B to ground, and C to ground, 9.9.9.9 with engine off.

Test 93, alternator ouput volts, measured from pin A to B, B to C, and A to C, with engine idling and with 12 volts DC applied to pin D, and with pin E grounded, 30 to 34 volts AC @ idle.

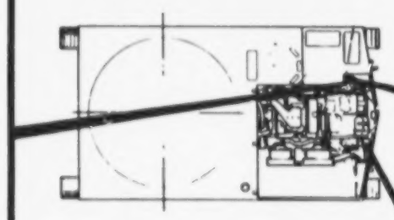


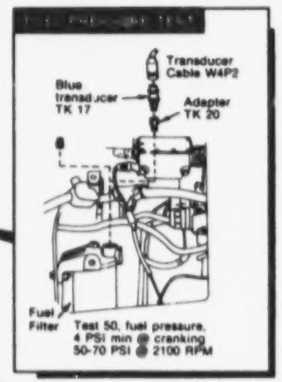
WARNING

When performing test 93, do not run engine above idle with voltage applied on pins D and E. Personal injury and equipment damage may result

Note: Perform the following test with the alternator cable connected to the regulator and the current probe positioned as shown. Be sure the probe is 10 in. or more away from other wires.

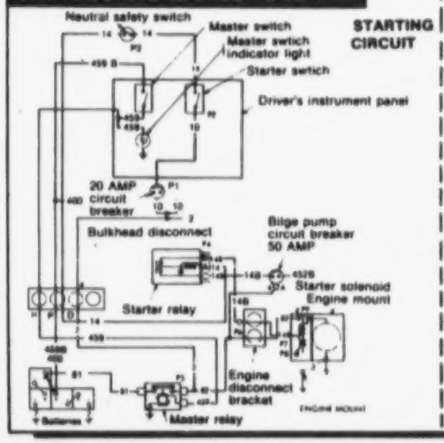
Test 90, alternator output current, 30 AMPS min at 1000-1200 RPM (accessories on & partially discharged)

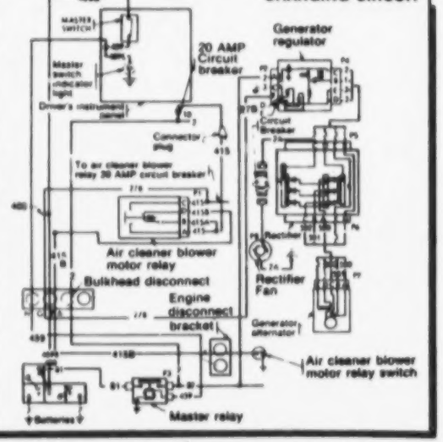


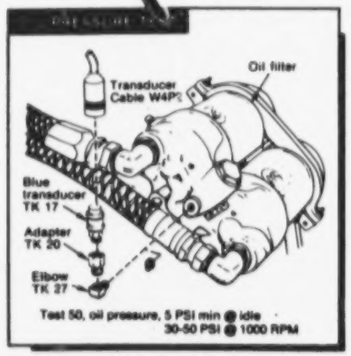


Test 50, fuel pressure, 4 PSI min @ cranking 50-70 PSI @ 2100 RPM

STARTING CIRCUIT DIAGRAMS







Test 50, oil pressure, 5 PSI min @ idle 30-50 PSI @ 1000 RPM

Test limits given are advisory only and are not necessarily the same as vehicle TM's specifications. If test limits are different, use vehicle TM's specifications.

M109 VEHICLE TEST CARD - VID 11 Additional Test Connections

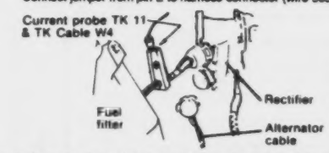
ALTERNATOR TESTS

Note: Perform the following tests with the alternator cable disconnected as shown.

Test 91, stator resistance measured from pin B to D, D to F, and B to F of alternator cable must be less than 5 ohms with engine off.

Test 92, stator insulation measured from pin B to ground, D to ground, and F to ground, 9.9.9.9 with engine off.

Test 93, alternator output volts, measured from pin B to D, D to F and B to F, with engine idling and with 12 volts DC applied to pin A and with pin C grounded, 30 to 34 volts AC @ idle. Connect jumper from pin E to harness connector (wire 503).

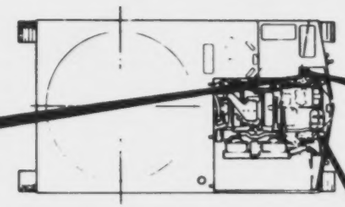


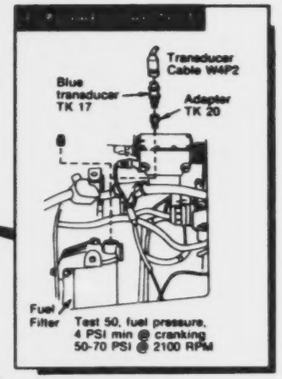
WARNING

When performing test 93, do not run engine above idle with voltage applied on pins D and E. Personal injury and equipment damage may result

Note: Perform the following test with the alternator cable connected to the regulator and the current probe positioned as shown. Be sure the probe is 10 in. or more away from other wires.

Test 90, alternator output current, 30 AMPS min at 1000-1200 RPM (accessories on & partially discharged)

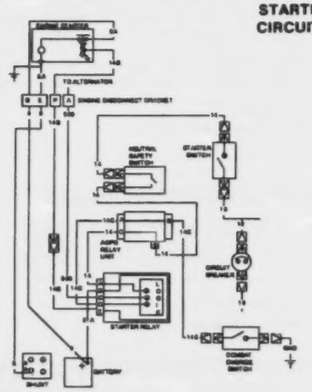




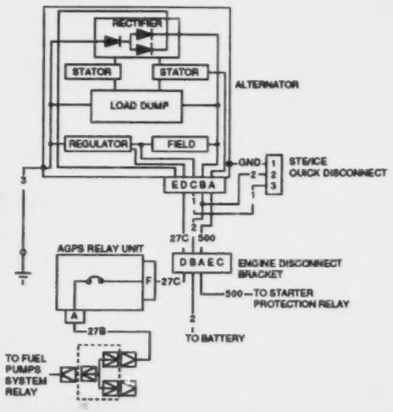
Test 50, fuel pressure, 4 PSI min @ cranking 50-70 PSI @ 2100 RPM

STARTING CHARGING CIRCUIT DIAGRAMS

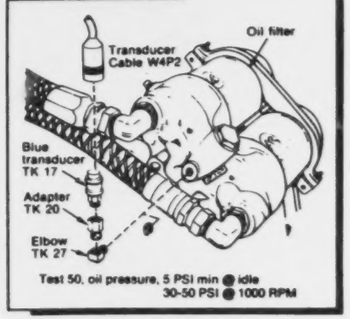
STARTING CIRCUIT



CHARGING CIRCUIT



OIL PRESSURE TEST



Test 50, oil pressure, 5 PSI min @ idle 30-50 PSI @ 1000 RPM

Test limits given are advisory only and are not necessarily the same as vehicle TM's specifications. If test limits are different, use vehicle TM's specifications.

GO 1 VTM CONNECTIONS AND CHECKOUT

WARNING

DO NOT CONNECT OR DISCONNECT VTM WHILE ENGINE IS RUNNING.

CAUTION

Connect P1 of power cable W5 to J1 on the VTM before connecting clip leads to battery.

1

CONNECT BATTERY TO VTM:

- Pull power switch on VTM to OFF position.
- Connect P1 of power cable W5 to J1 on the VTM.
- Connect the red clip lead of cable W5 to the positive terminal of M109A2/A3/A4 battery.
- Connect the black clip lead of cable W5 to the negative terminal of M109A2/A3/A4 battery.

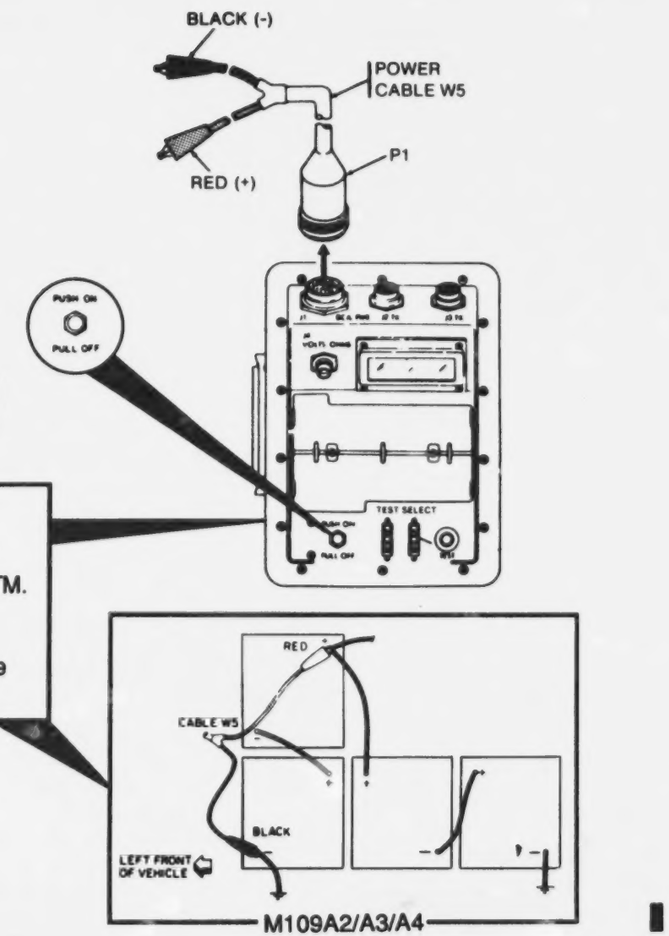


FIGURE 1. SHEET 2 OF 22

NOTE

Make sure all connections are correct and secure.

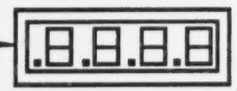
NOTE

On some vehicles, sparking may occur if the VTM power is on and its case touches the vehicle while the master switch is off. This can happen on vehicles with master relay in the negative battery cable. Sparking won't hurt the VTM or the vehicle but it will interupt testing. You can prevent it by setting the VTM down so that only the rubber feet touches the vehicle, or by doing all testing with the master switch on.

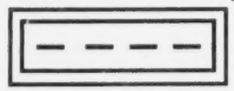
2

POWER UP:

- Push power switch on VTM to ON position.
- Verify that display indicates .8.8.8.8 for approximately 2 seconds and then changes to - - - - .



AFTER 2 SECONDS



- Does the VTM display .8.8.8.8 and then change to - - - - ?

YES

NO

Does display light up?

YES

NO

If only a portion of .8.8.8.8 or - - - - is displayed, a display module may be burned out. Go to TM 9-4910-571-12&P for module replacement.

- Pull power switch to OFF position.
- Check W5 for proper connections. Red lead on positive terminal, black lead on negative terminal.
- Check and clean all battery connections and interconnecting cables.
- Push power switch to ON position.
- Does the VTM display .8.8.8.8 and then change to - - - - ?

Go to step 4, FIGURE 1, SHEET 5.

YES

NO

Go to step 3, FIGURE 1, SHEET 4.

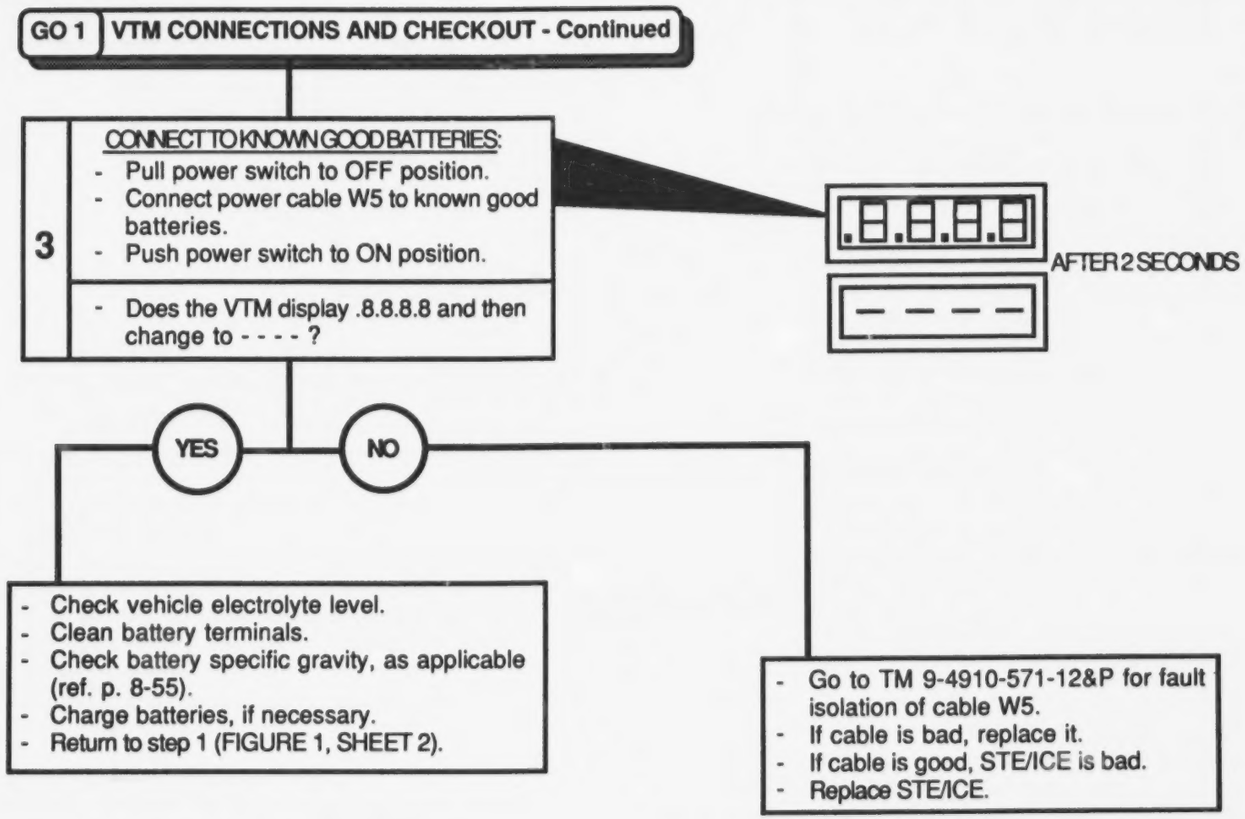

GO 1
VTM CONNECTIONS AND CHECKOUT - Continued
3
CONNECT TO KNOWN GOOD BATTERIES:
- Pull power switch to OFF position.
- Connect power cable W5 to known good batteries.
- Push power switch to ON position.
- Does the VTM display .8.8.8.8 and then change to - - - - ?
.8.8.8.8
AFTER 2 SECONDS
- - - -
YES
NO
- Check vehicle electrolyte level.
- Clean battery terminals.
- Check battery specific gravity, as applicable (ref. p. 8-55).
- Charge batteries, if necessary.
- Return to step 1 (FIGURE 1, SHEET 2).
- Go to TM 9-4910-571-12&P for fault isolation of cable W5.
- If cable is bad, replace it.
- If cable is good, STE/ICE is bad.
- Replace STE/ICE.

FIGURE 1. SHEET 4 OF 22

GO 1 **VTM CONNECTIONS AND CHECKOUT - Continued**

4

RUN CONFIDENCE TEST:
- Dial 66 into TEST SELECT, press and release TEST button.
- Wait for a readout of 0066 on the VTM.

- Does the VTM display and hold 0066?

YES

NO

- Pull power switch on VTM to OFF position.
- Repeat steps 2 and 4 one time.

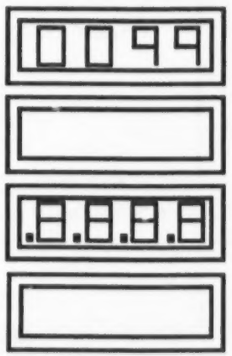
- Does the VTM display and hold 0066?

YES

NO

STE/ICE is bad; replace.

Dial 99 into TEST SELECT, press and release TEST button. Look for this display.



Check display to assure that 0099 and .8.8.8.8 appear correctly. If all segments of display are not on, go to TM 9-4910-571-12&P to replace display module.

At this point in the test, several numbers will appear on the display. The numbers displayed indicate the VTM is going through confidence test. You are looking for a display and hold of PASS.

Go to FIGURE 1, SHEET 6.

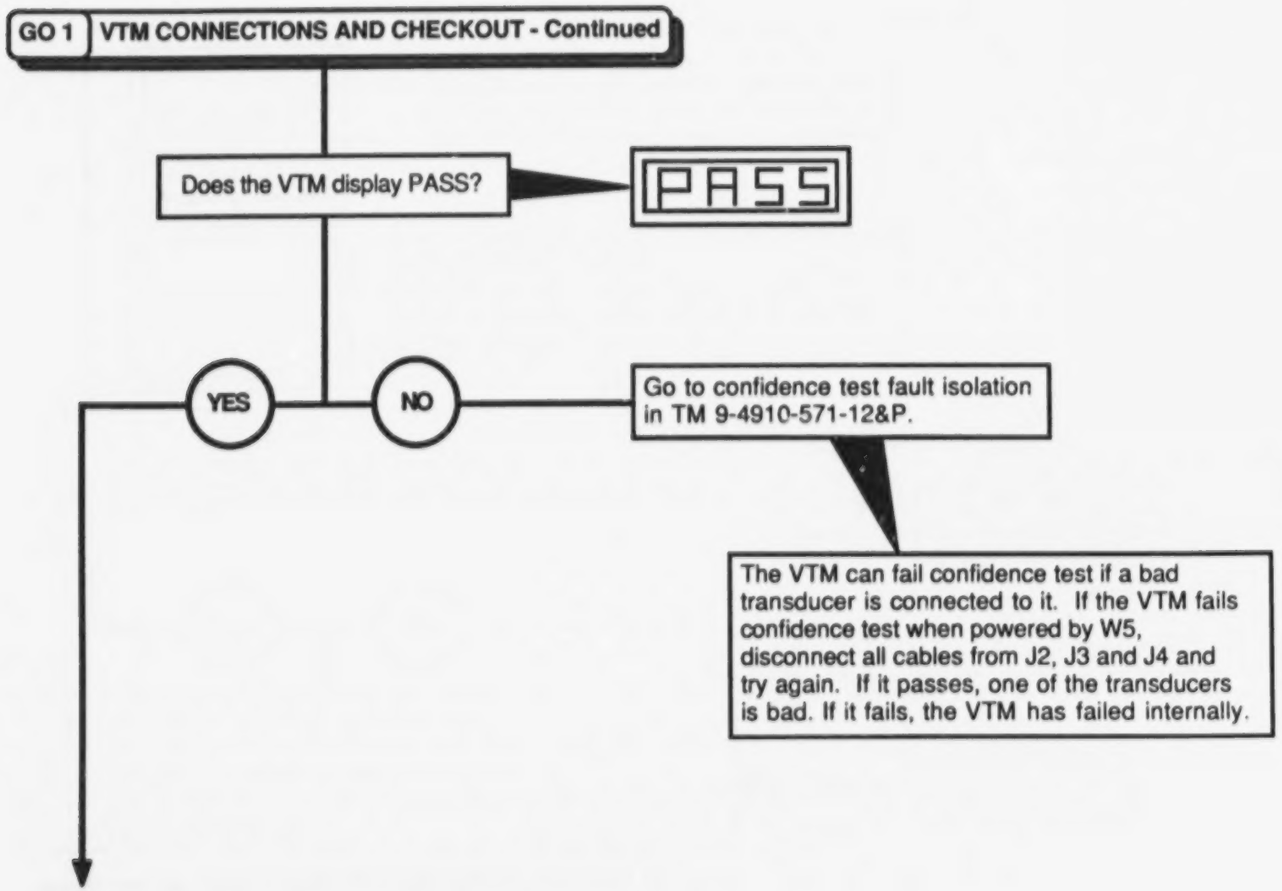

GO 1 VTM CONNECTIONS AND CHECKOUT - Continued
Does the VTM display PASS?
PASS
YES
NO
Go to confidence test fault isolation in TM 9-4910-571-12&P.
The VTM can fail confidence test if a bad transducer is connected to it. If the VTM fails confidence test when powered by W5, disconnect all cables from J2, J3 and J4 and try again. If it passes, one of the transducers is bad. If it fails, the VTM has failed internally.

FIGURE 1. SHEET 6 OF 22

- Dial 67 into TEST SELECT, press and release TEST button.
- Watch the display and verify that the battery voltage is above + 22 VDC.

- Is the battery voltage above + 22 VDC?

YES

NO

- Check VTM connections.
- Clean battery connections.
- Go to p. 8-55 to check battery specific gravity.
- Charge batteries, if necessary.
- Go to cable fault isolation procedure in TM 9-4910-571-12&P and troubleshoot cable W5.

NOTE

After completing repair, rerun the GO-chain tests to verify that the problem is fixed and that no other problems exist. Start at GO 1 (FIGURE 1, SHEET 2).

Go to step 5, FIGURE 1, SHEET 8.

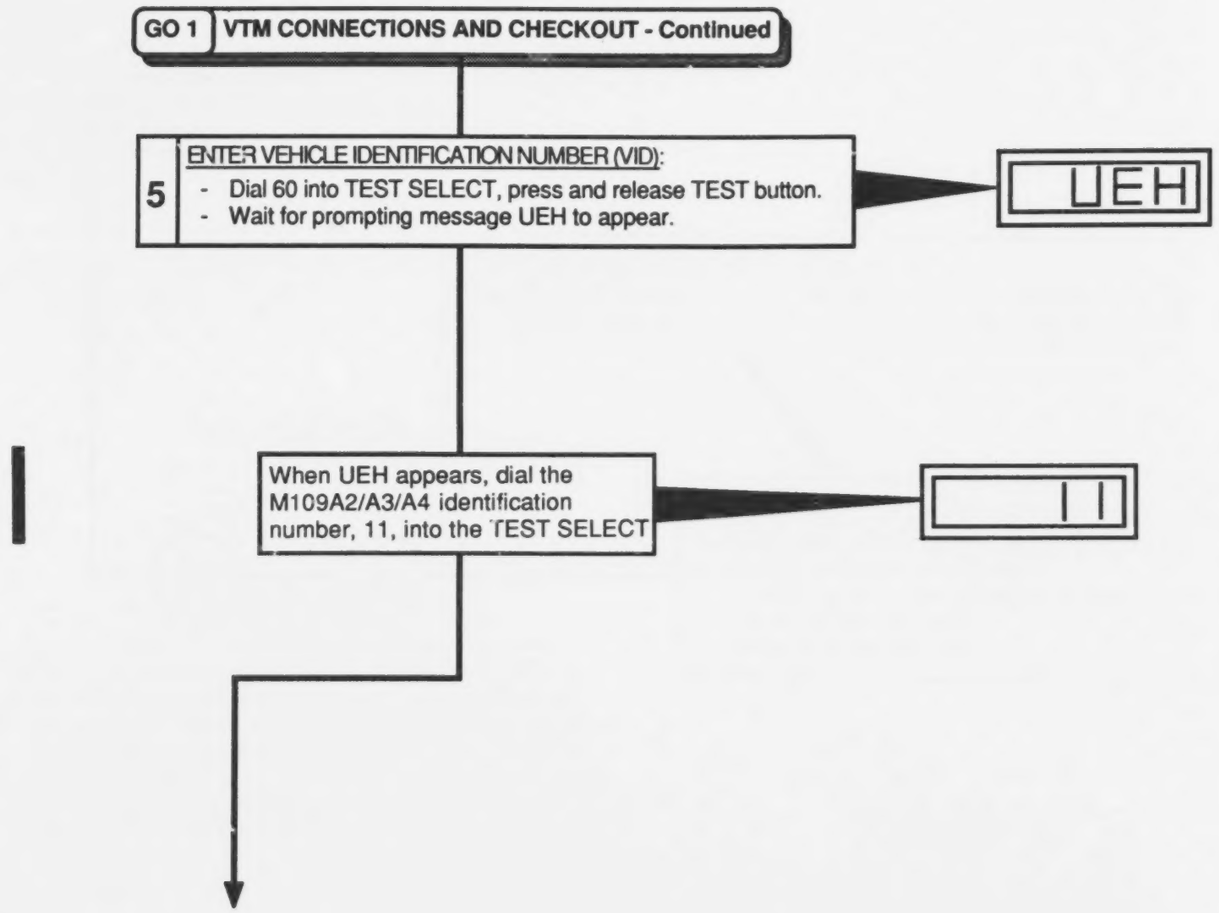
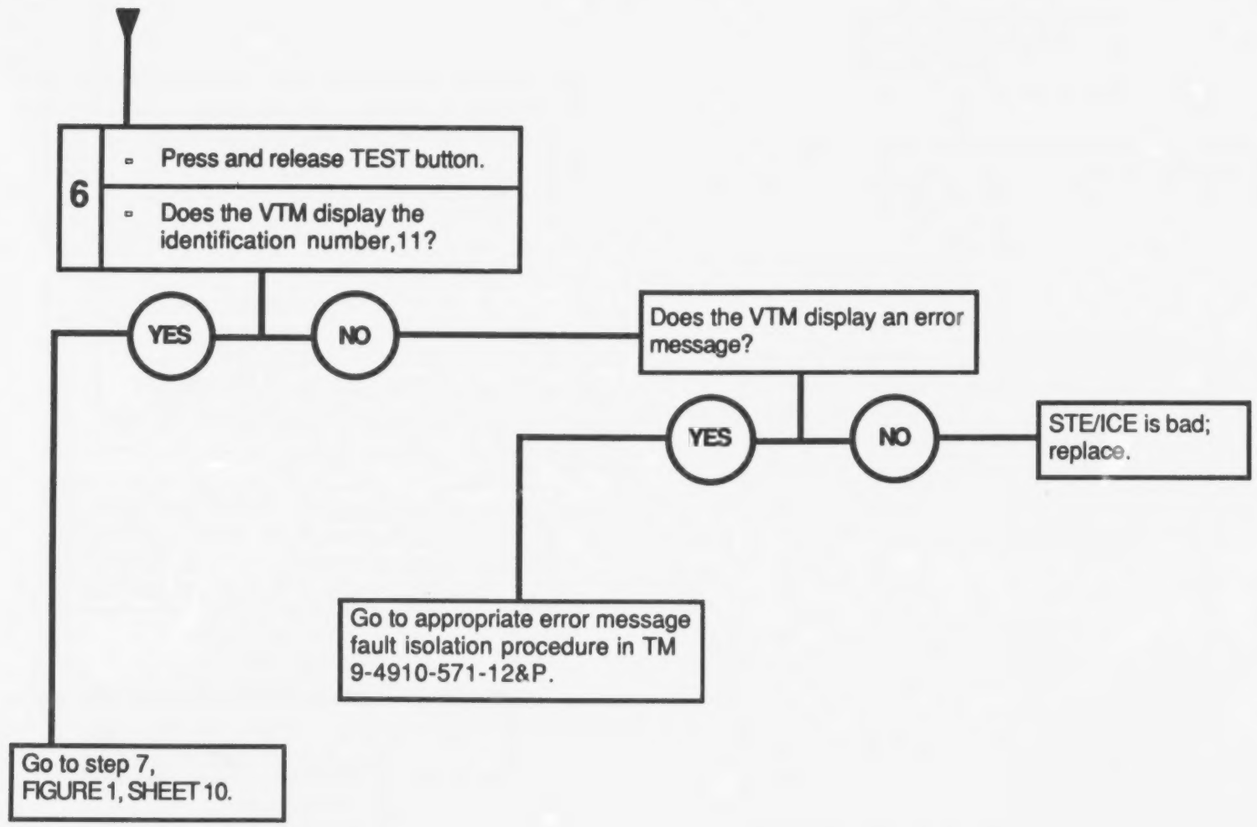

GO 1 VTM CONNECTIONS AND CHECKOUT - Continued
5
ENTER VEHICLE IDENTIFICATION NUMBER (VID):
- Dial 60 into TEST SELECT, press and release TEST button.
- Wait for prompting message UEH to appear.
UEH
When UEH appears, dial the M109A2/A3/A4 identification number, 11, into the TEST SELECT
11

FIGURE 1. SHEET 8 OF 22


6
Press and release TEST button.
Does the VTM display the identification number,11?
YES
NO
Does the VTM display an error message?
YES
NO
STE/ICE is bad; replace.
Go to appropriate error message fault isolation procedure in TM 9-4910-571-12&P.
Go to step 7, FIGURE 1, SHEET 10.

GO 1 **VTM CONNECTIONS AND CHECKOUT - Continued**

WARNING

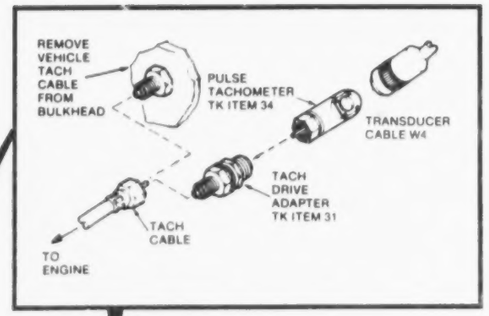
TURN ENGINE OFF BEFORE INSTALLING PULSE TACHOMETER.

CAUTION

Clean all mounting surfaces before installing the transducer to prevent the entry of foreign substances that may damage the engine or transducer.

7 INSTALL PULSE TACHOMETER (TK ITEM 34):
- Go to page 9-55 to disconnect the tachometer cable.
- Install pulse tachometer in place of the removed tachometer cable.

8 MAKE CABLE CONNECTIONS:
- Connect P1 of the transducer cable W4 to J2 on the VTM.
- Connect P2 of the transducer cable to the connector on the pulse tachometer.


REMOVE VEHICLE TACH CABLE FROM BULKHEAD
PULSE TACHOMETER TK ITEM 34
TRANSDUCER CABLE W4
TACH DRIVE ADAPTER TK ITEM 31
TACH CABLE
TO ENGINE

NOTE

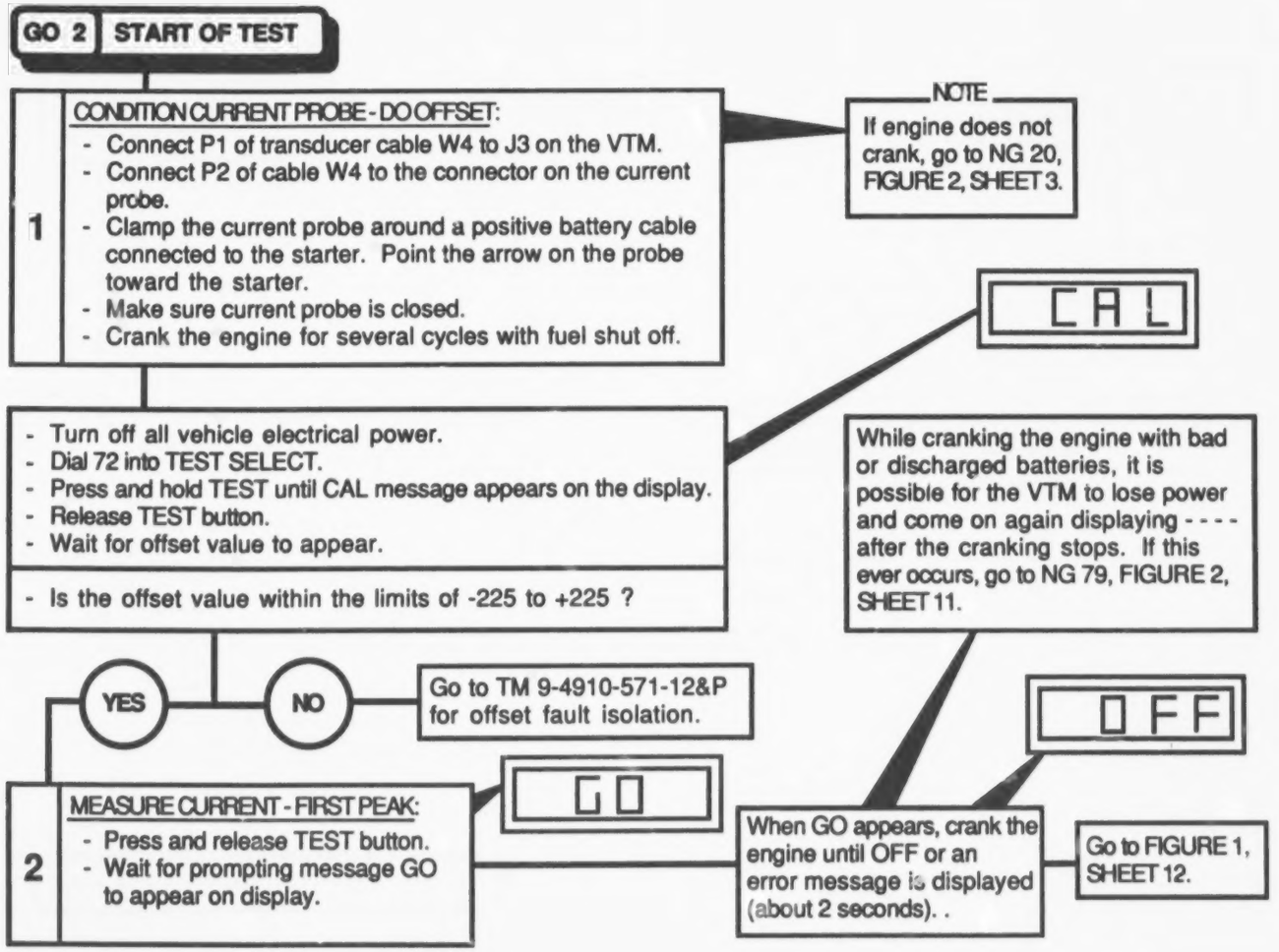
If RPM or power tests vary more than + 5%, remove the tach drive adapter and pulse tachometer from the tach cable. Connect the pulse tachometer to the tach cable interface on the engine. Rotation of the vehicle tach speed adapter may be required to connect the pulse tachometer.

CAUTION

Be sure cable W4 is clear of belts and fan blades.

Go to GO 2, FIGURE 1, SHEET11.

FIGURE 1. SHEET 10 OF 22


GO 2 START OF TEST
1
CONDITION CURRENT PROBE - DO OFFSET:
- Connect P1 of transducer cable W4 to J3 on the VTM.
- Connect P2 of cable W4 to the connector on the current probe.
- Clamp the current probe around a positive battery cable connected to the starter. Point the arrow on the probe toward the starter.
- Make sure current probe is closed.
- Crank the engine for several cycles with fuel shut off.
NOTE
If engine does not crank, go to NG 20, FIGURE 2, SHEET 3.
CAL
- Turn off all vehicle electrical power.
- Dial 72 into TEST SELECT.
- Press and hold TEST until CAL message appears on the display.
- Release TEST button.
- Wait for offset value to appear.
While cranking the engine with bad or discharged batteries, it is possible for the VTM to lose power and come on again displaying - - - - after the cranking stops. If this ever occurs, go to NG 79, FIGURE 2, SHEET 11.
- Is the offset value within the limits of -225 to +225 ?
YES
NO
Go to TM 9-4910-571-12&P for offset fault isolation.
OFF
2
MEASURE CURRENT - FIRST PEAK:
- Press and release TEST button.
- Wait for prompting message GO to appear on display.
GO
When GO appears, crank the engine until OFF or an error message is displayed (about 2 seconds). .
Go to FIGURE 1, SHEET 12.

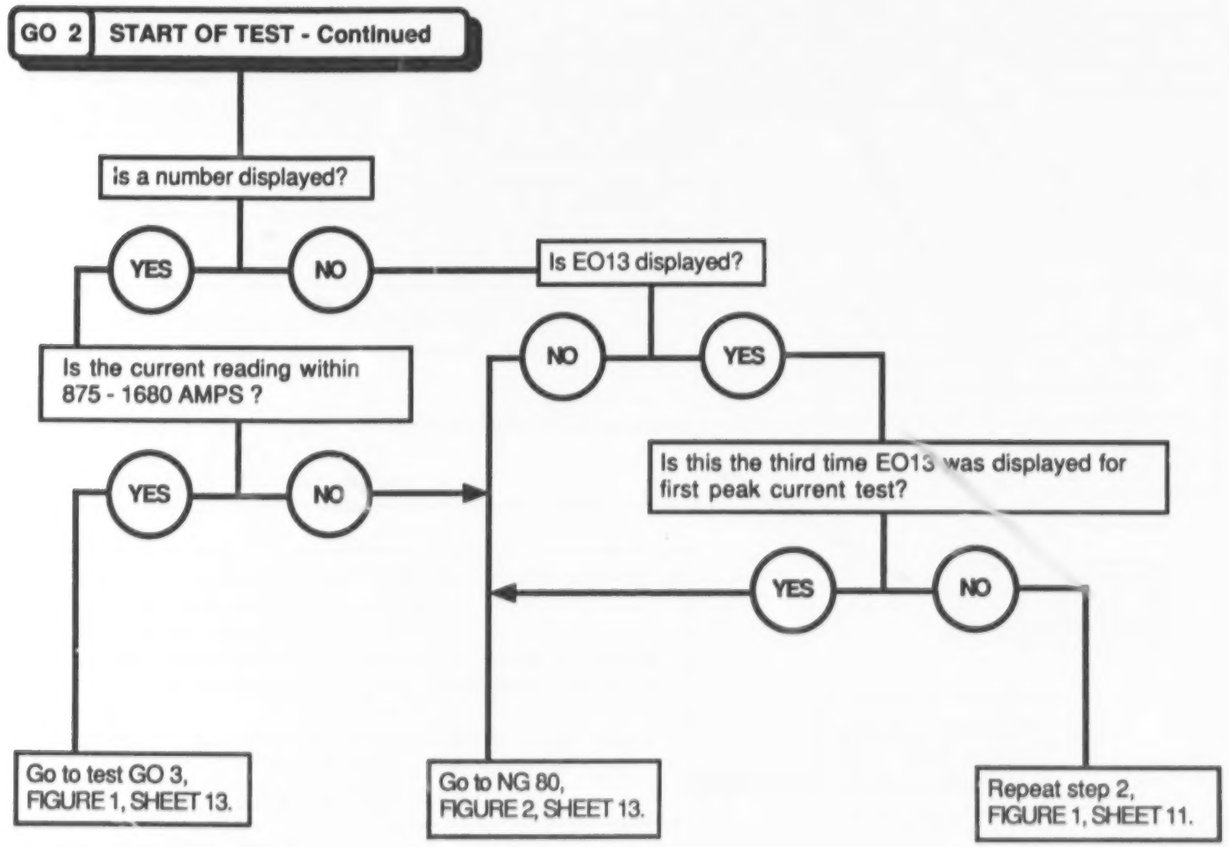
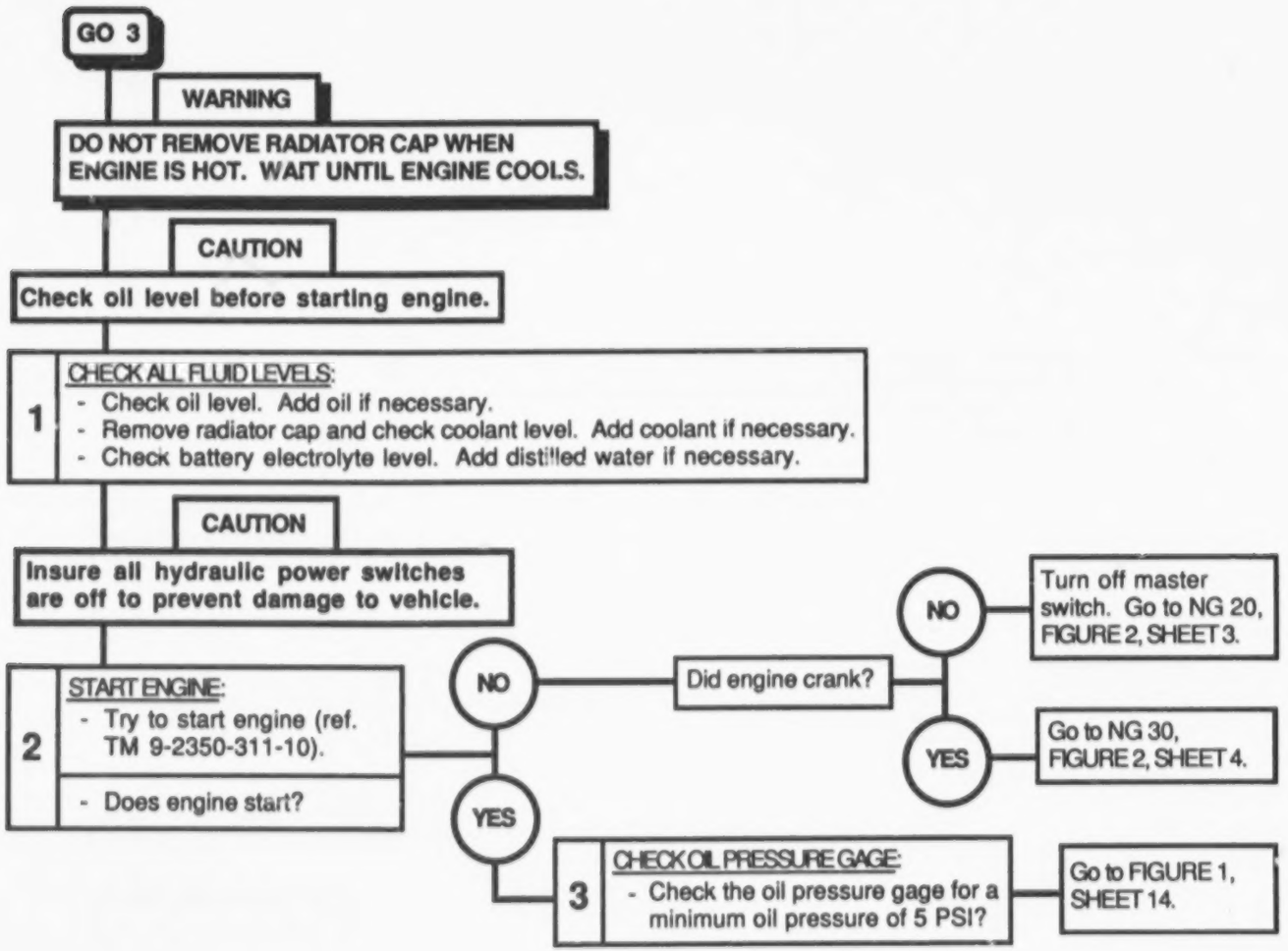

GO 2 START OF TEST - Continued
Is a number displayed?
YES
NO
Is the current reading within 875 - 1680 AMPS ?
YES
NO
Is EO13 displayed?
NO
YES
Is this the third time EO13 was displayed for first peak current test?
YES
NO
Go to test GO 3, FIGURE 1, SHEET 13.
Go to NG 80, FIGURE 2, SHEET 13.
Repeat step 2, FIGURE 1, SHEET 11.

FIGURE 1. SHEET 12 OF 22


GO 3
WARNING
DO NOT REMOVE RADIATOR CAP WHEN ENGINE IS HOT. WAIT UNTIL ENGINE COOLS.
CAUTION
Check oil level before starting engine.
1
CHECK ALL FLUID LEVELS:
- Check oil level. Add oil if necessary.
- Remove radiator cap and check coolant level. Add coolant if necessary.
- Check battery electrolyte level. Add distilled water if necessary.
CAUTION
Insure all hydraulic power switches are off to prevent damage to vehicle.
2
START ENGINE:
- Try to start engine (ref. TM 9-2350-311-10).
- Does engine start?
NO
Did engine crank?
NO
Turn off master switch. Go to NG 20, FIGURE 2, SHEET 3.
YES
Go to NG 30, FIGURE 2, SHEET 4.
YES
3
CHECK OIL PRESSURE GAGE:
- Check the oil pressure gage for a minimum oil pressure of 5 PSI?
Go to FIGURE 1, SHEET 14.

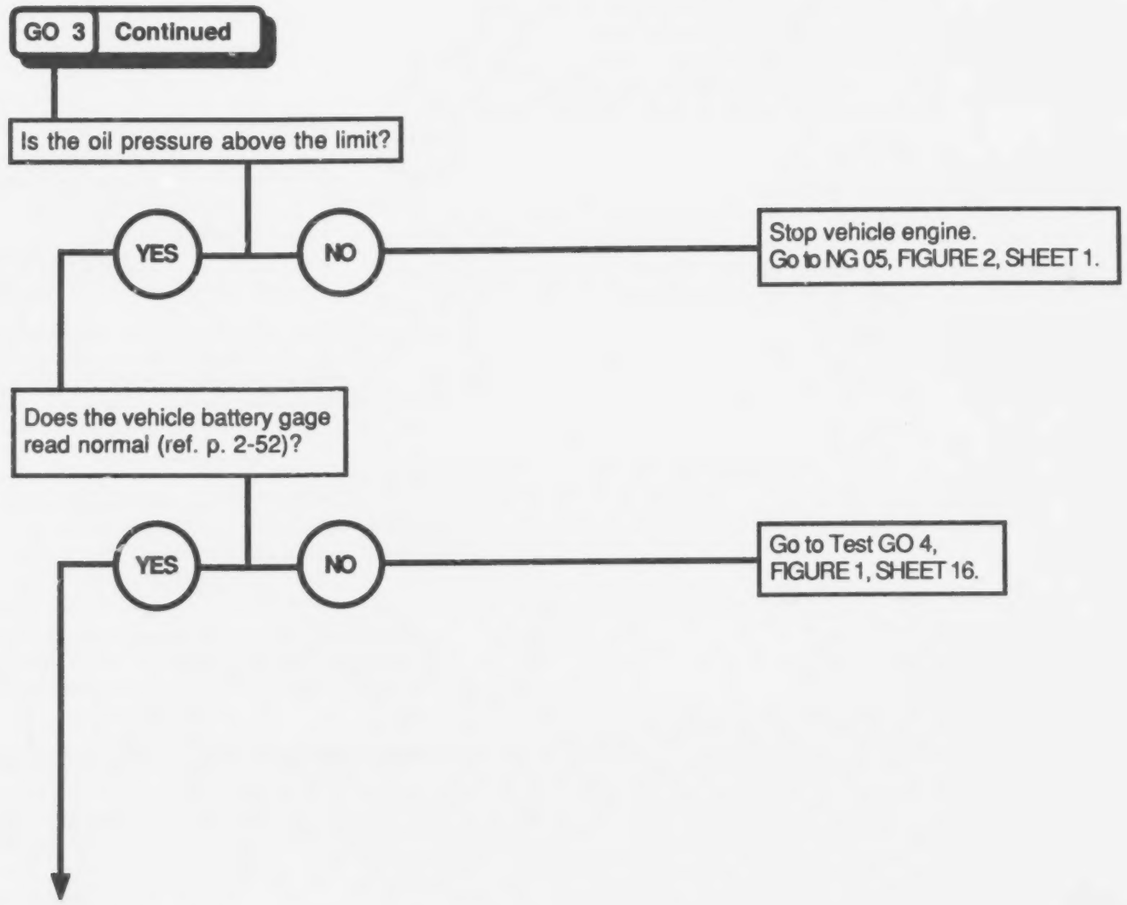
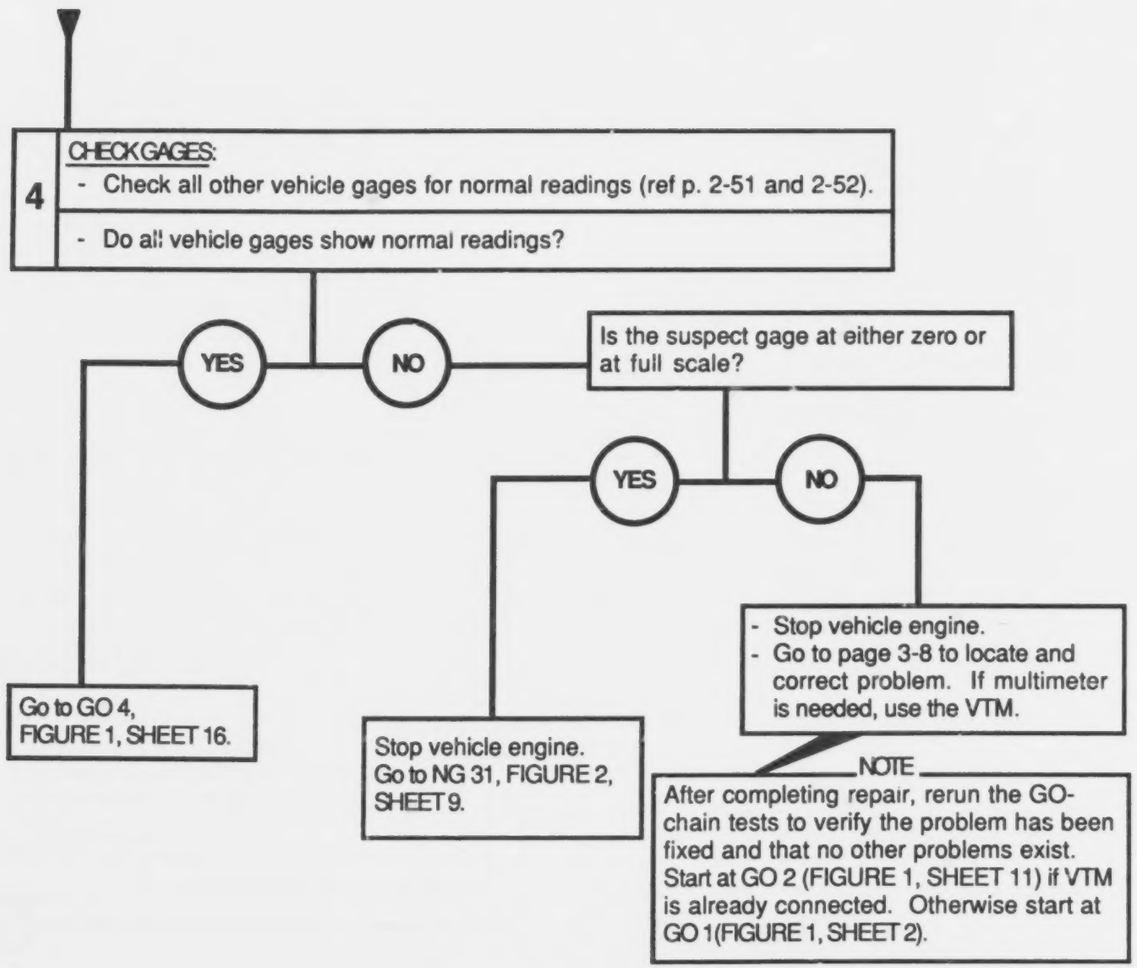

GO 3 Continued
Is the oil pressure above the limit?
YES
NO
Stop vehicle engine.
Go to NG 05, FIGURE 2, SHEET 1.
Does the vehicle battery gage read normal (ref. p. 2-52)?
YES
NO
Go to Test GO 4,
FIGURE 1, SHEET 16.

FIGURE 1. SHEET 14 OF 22


4
CHECK GAGES:
- Check all other vehicle gages for normal readings (ref p. 2-51 and 2-52).
- Do all vehicle gages show normal readings?
YES
NO
Is the suspect gage at either zero or at full scale?
YES
NO
Go to GO 4, FIGURE 1, SHEET 16.
Stop vehicle engine. Go to NG 31, FIGURE 2, SHEET 9.
- Stop vehicle engine.
- Go to page 3-8 to locate and correct problem. If multimeter is needed, use the VTM.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1(FIGURE 1, SHEET 2).

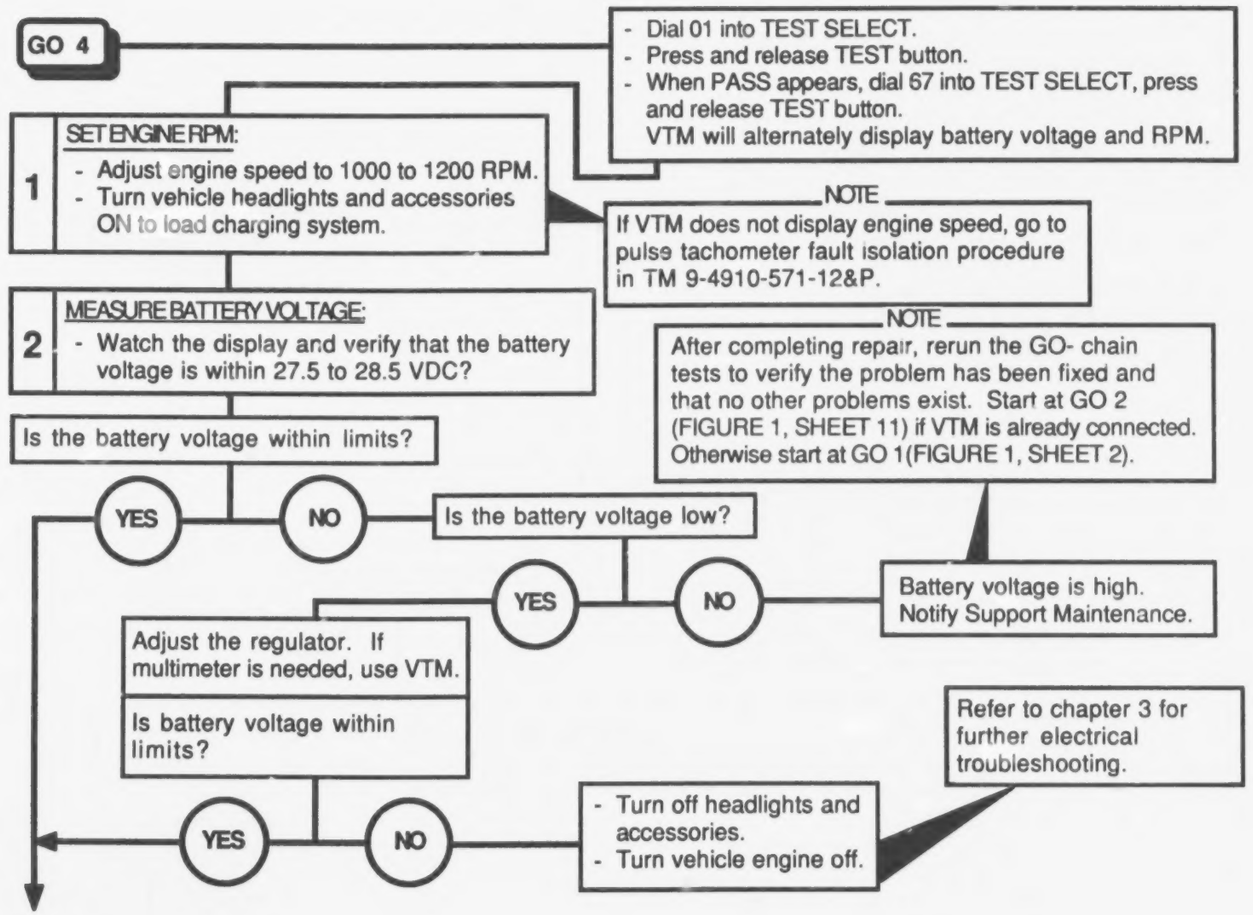
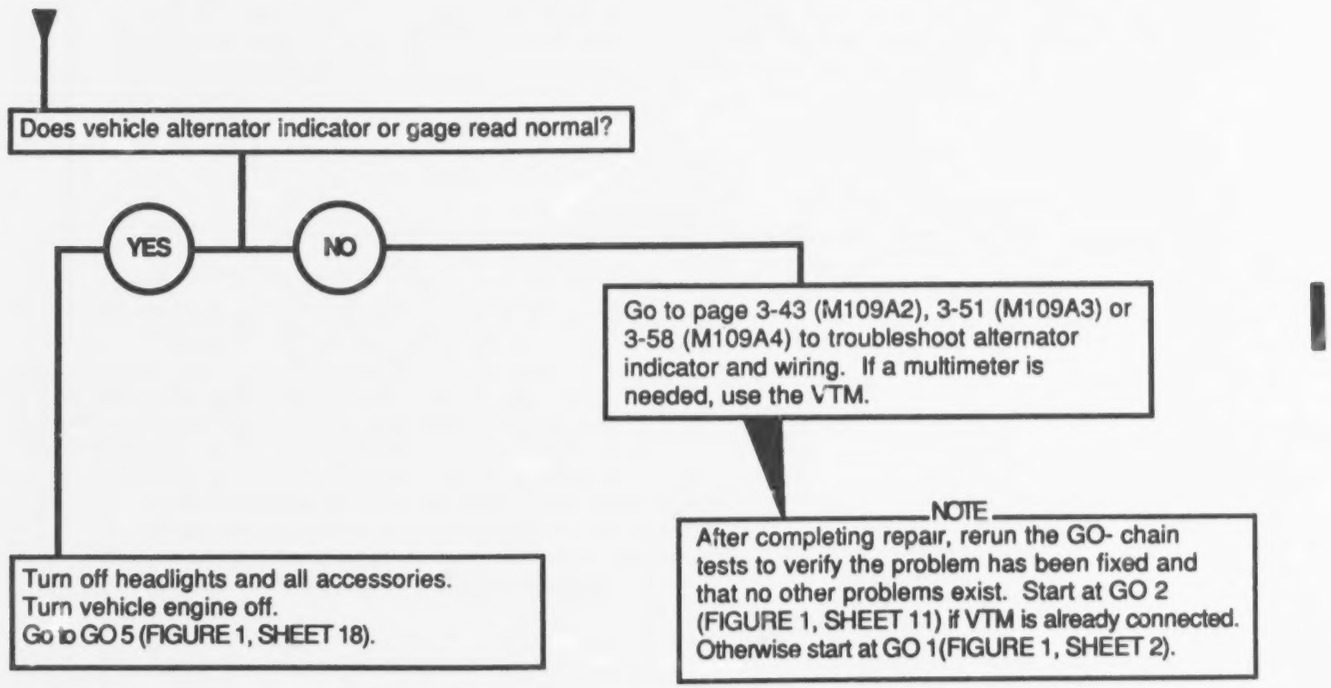

GO 4
- Dial 01 into TEST SELECT.
- Press and release TEST button.
- When PASS appears, dial 67 into TEST SELECT, press and release TEST button.
VTM will alternately display battery voltage and RPM.
1
SET ENGINE RPM:
- Adjust engine speed to 1000 to 1200 RPM.
- Turn vehicle headlights and accessories ON to load charging system.
NOTE
If VTM does not display engine speed, go to pulse tachometer fault isolation procedure in TM 9-4910-571-12&P.
2
MEASURE BATTERY VOLTAGE:
- Watch the display and verify that the battery voltage is within 27.5 to 28.5 VDC?
NOTE
After completing repair, rerun the GO- chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1(FIGURE 1, SHEET 2).
Is the battery voltage within limits?
YES
NO
Is the battery voltage low?
YES
NO
Battery voltage is high.
Notify Support Maintenance.
Adjust the regulator. If multimeter is needed, use VTM.
Is battery voltage within limits?
YES
NO
- Turn off headlights and accessories.
- Turn vehicle engine off.
Refer to chapter 3 for further electrical troubleshooting.

FIGURE 1. SHEET 16 OF 22


Does vehicle alternator indicator or gage read normal?
YES
NO
Turn off headlights and all accessories.
Turn vehicle engine off.
Go to GO 5 (FIGURE 1, SHEET 18).
Go to page 3-43 (M109A2), 3-51 (M109A3) or 3-58 (M109A4) to troubleshoot alternator indicator and wiring. If a multimeter is needed, use the VTM.
NOTE
After completing repair, rerun the GO- chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1(FIGURE 1, SHEET 2).

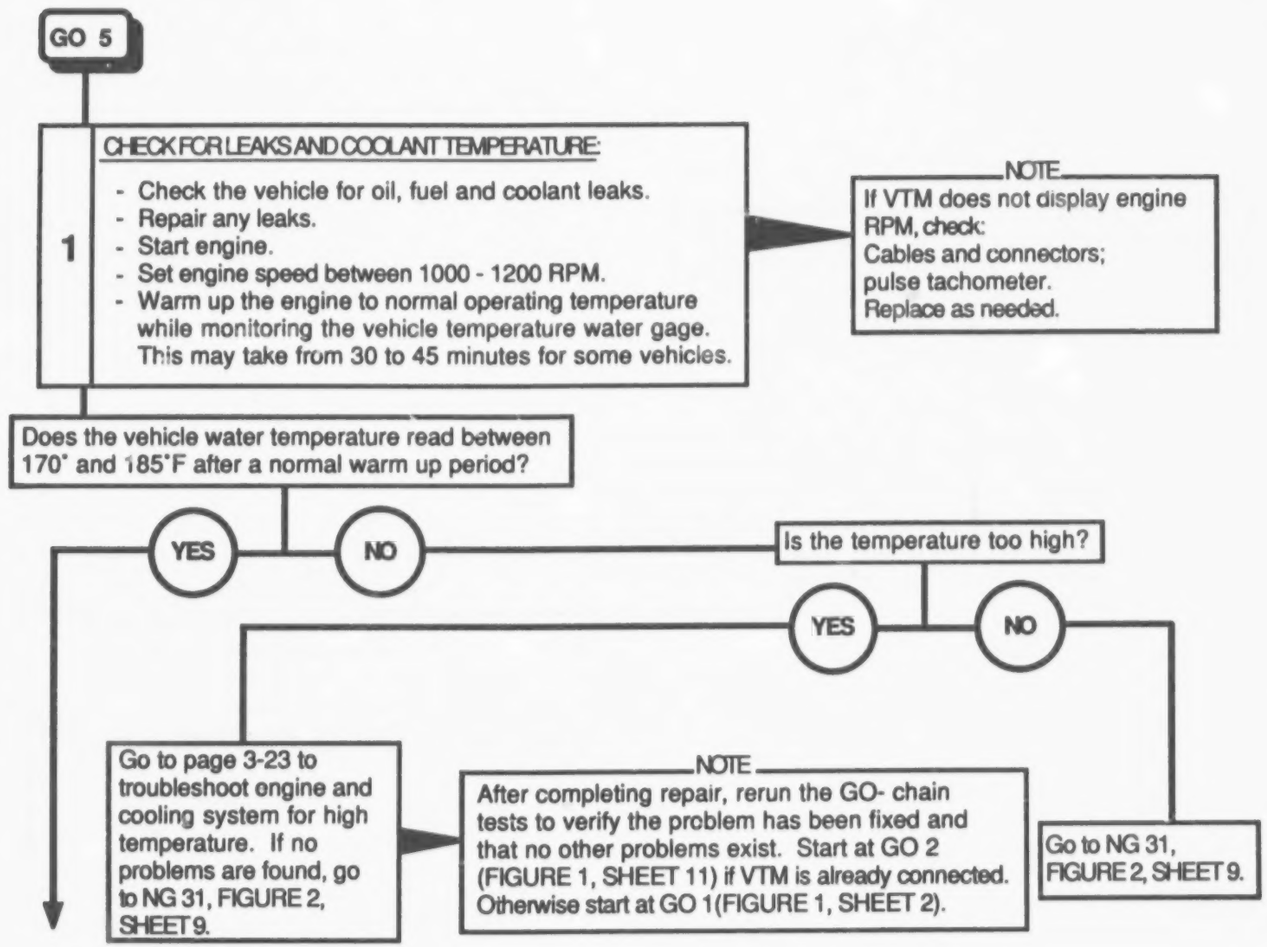
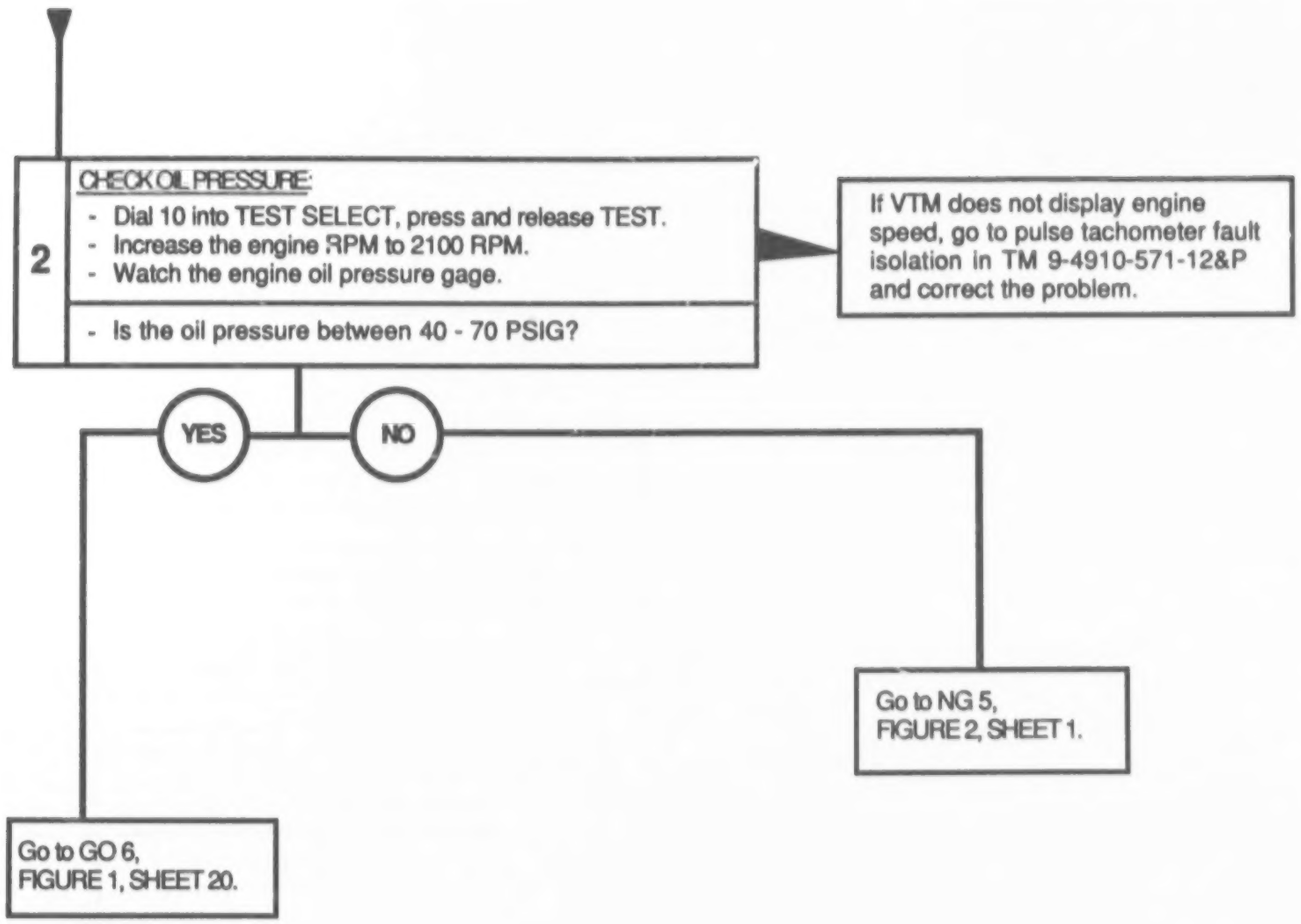

GO 5
1
CHECK FOR LEAKS AND COOLANT TEMPERATURE:
- Check the vehicle for oil, fuel and coolant leaks.
- Repair any leaks.
- Start engine.
- Set engine speed between 1000 - 1200 RPM.
- Warm up the engine to normal operating temperature while monitoring the vehicle temperature water gage. This may take from 30 to 45 minutes for some vehicles.
NOTE
If VTM does not display engine RPM, check:
Cables and connectors;
pulse tachometer.
Replace as needed.
Does the vehicle water temperature read between 170° and 185°F after a normal warm up period?
YES
NO
Is the temperature too high?
YES
NO
Go to page 3-23 to troubleshoot engine and cooling system for high temperature. If no problems are found, go to NG 31, FIGURE 2, SHEET 9.
NOTE
After completing repair, rerun the GO- chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1(FIGURE 1, SHEET 2).
Go to NG 31, FIGURE 2, SHEET 9.

FIGURE 1. SHEET 18 OF 22


2
CHECK OIL PRESSURE:
- Dial 10 into TEST SELECT, press and release TEST.
- Increase the engine RPM to 2100 RPM.
- Watch the engine oil pressure gage.
- Is the oil pressure between 40 - 70 PSIG?
If VTM does not display engine speed, go to pulse tachometer fault isolation in TM 9-4910-571-12&P and correct the problem.
YES
NO
Go to GO 6, FIGURE 1, SHEET 20.
Go to NG 5, FIGURE 2, SHEET 1.

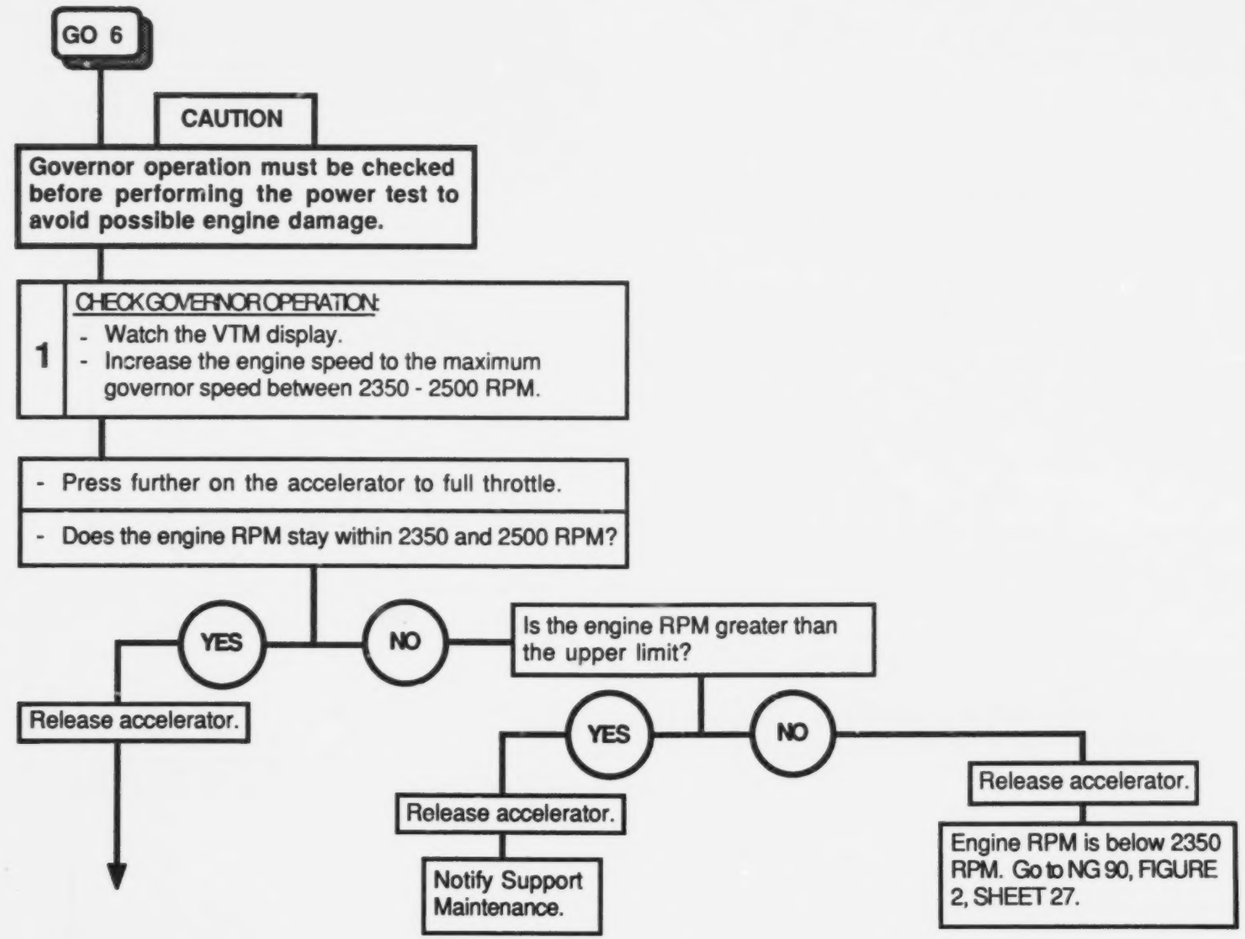

GO 6
CAUTION
Governor operation must be checked before performing the power test to avoid possible engine damage.
1
CHECK GOVERNOR OPERATION:
- Watch the VTM display.
- Increase the engine speed to the maximum governor speed between 2350 - 2500 RPM.
- Press further on the accelerator to full throttle.
- Does the engine RPM stay within 2350 and 2500 RPM?
YES
NO
Is the engine RPM greater than the upper limit?
Release accelerator.
YES
NO
Release accelerator.
Notify Support Maintenance.
Release accelerator.
Engine RPM is below 2350 RPM. Go to NG 90, FIGURE 2, SHEET 27.

FIGURE 1. SHEET 20 OF 22

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CAUTION

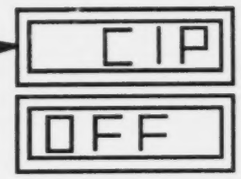
Do not perform the power test if the engine is above the normal operating temperature. However, the engine should be at operating temperature before performing the power test.

NOTE

Engine has to be running below 1000 RPM before power test.

2 PERFORM POWER TEST:

- Dial 13 into TEST SELECT, press and release TEST button.
- Wait for prompting message CIP to appear.
- When CIP appears, rapidly press down on the accelerator and hold it to the floor until the VTM displays OFF.
- When OFF appears, release the accelerator.
- A number representing % power will appear on the VTM display. Compare this number to the table below.



PROMPTING MESSAGES

% POWER: MINIMUM TEST LIMIT		
0 TO 2000 FT	2000 TO 4000 FT	ABOVE 4000 FT
75%	68%	60%

Is the power above the minimum test limit noted in the table above ?

YES → Go to GO 7, FIGURE 1, SHEET 22.

NO → Go to NG 90, FIGURE 2, SHEET 27.

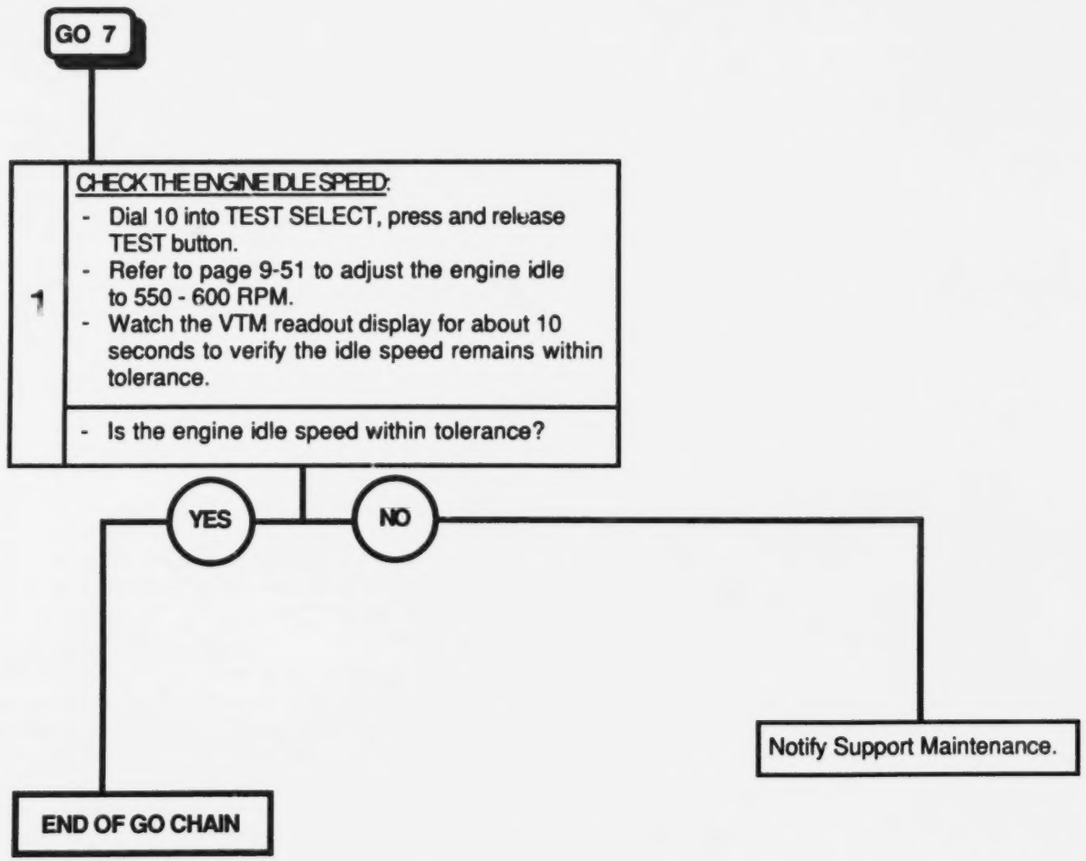

GO 7
CHECK THE ENGINE IDLE SPEED:
- Dial 10 into TEST SELECT, press and release TEST button.
- Refer to page 9-51 to adjust the engine idle to 550 - 600 RPM.
- Watch the VTM readout display for about 10 seconds to verify the idle speed remains within tolerance.
1
- Is the engine idle speed within tolerance?
YES
NO
Notify Support Maintenance.
END OF GO CHAIN

FIGURE 1. SHEET 22 OF 22

NG 5

1 INSTALL TRANSDUCER - DO OFFSET:
- Stop vehicle engine.
- Remove oil pressure sending unit (ref. p. 8-12).
- Install blue striped pressure transducer, TK item 17, in place of sending unit on engine.
- Connect P1of the transducer cable W4 to J3 on the VTM.
- Connect P2 of the transducer cable to the connector on the pressure transducer.

- Dial 50 into TEST SELECT.
- Press and hold TEST until CAL message appears on display.
- Release TEST button.
- Wait for offset value to appear on the display.

CAL

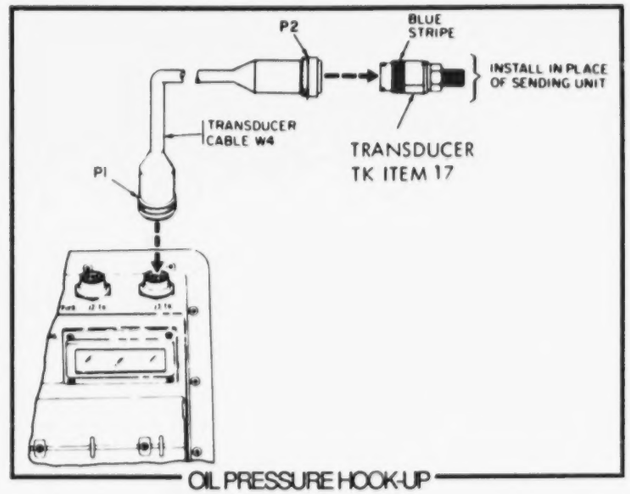
PROMPTING MESSAGE

- Is the offset value within the limits of -150 to +150?

YES

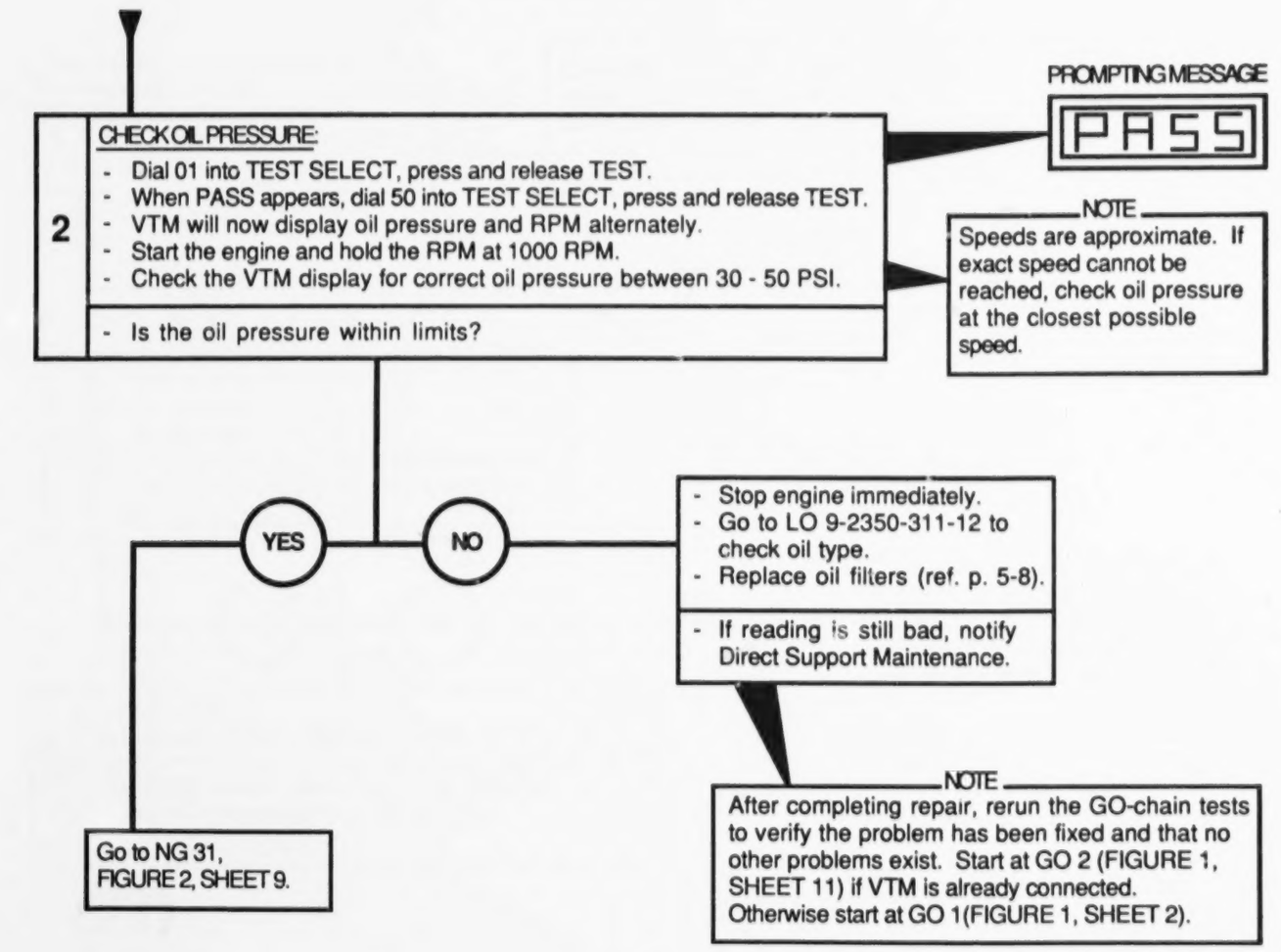
NO

Go to TM 9-4910-571-12&P for offset fault isolation.



OIL PRESSURE HOOK-UP

FIGURE 2. SHEET 1 OF 32


2
CHECK OIL PRESSURE:
- Dial 01 into TEST SELECT, press and release TEST.
- When PASS appears, dial 50 into TEST SELECT, press and release TEST.
- VTM will now display oil pressure and RPM alternately.
- Start the engine and hold the RPM at 1000 RPM.
- Check the VTM display for correct oil pressure between 30 - 50 PSI.
- Is the oil pressure within limits?
PROMPTING MESSAGE
PASS
NOTE
Speeds are approximate. If exact speed cannot be reached, check oil pressure at the closest possible speed.
YES
NO
- Stop engine immediately.
- Go to LO 9-2350-311-12 to check oil type.
- Replace oil filters (ref. p. 5-8).
- If reading is still bad, notify Direct Support Maintenance.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1(FIGURE 1, SHEET 2).
Go to NG 31, FIGURE 2, SHEET 9.

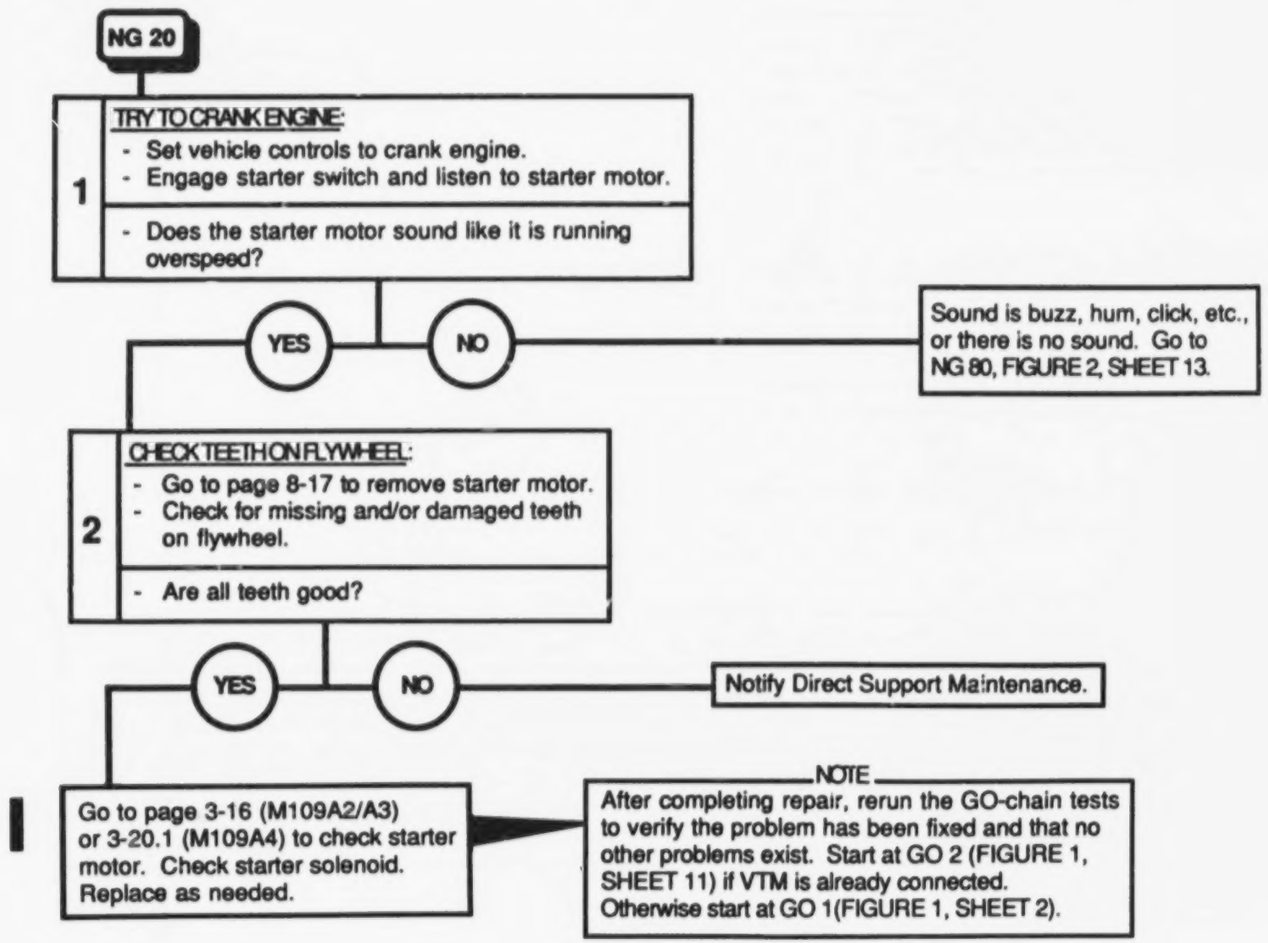
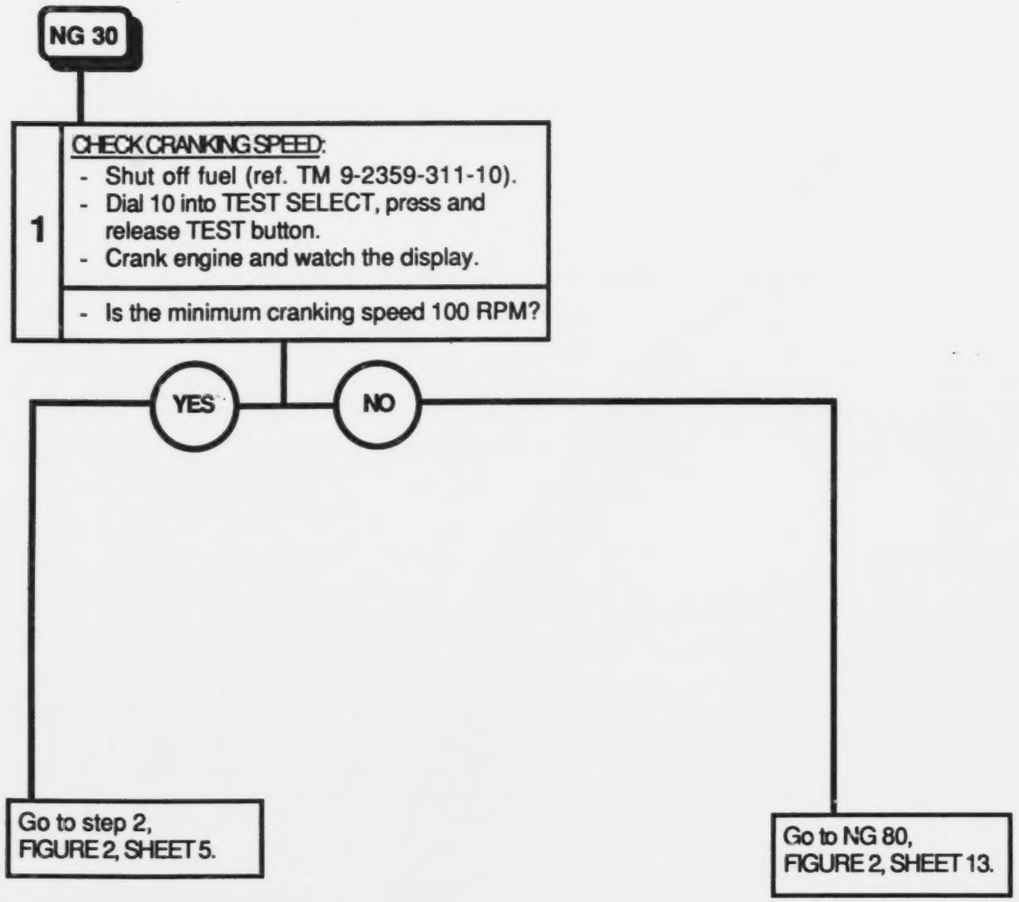

NG 20
1
TRY TO CRANK ENGINE:
- Set vehicle controls to crank engine.
- Engage starter switch and listen to starter motor.
- Does the starter motor sound like it is running overspeed?
YES
NO
Sound is buzz, hum, click, etc., or there is no sound. Go to NG 80, FIGURE 2, SHEET 13.
2
CHECK TEETH ON FLYWHEEL:
- Go to page 8-17 to remove starter motor.
- Check for missing and/or damaged teeth on flywheel.
- Are all teeth good?
YES
NO
Notify Direct Support Maintenance.
Go to page 3-16 (M109A2/A3) or 3-20.1 (M109A4) to check starter motor. Check starter solenoid. Replace as needed.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1(FIGURE 1, SHEET 2).

FIGURE 2. SHEET 3 OF 32


NG 30
1
CHECK CRANKING SPEED:
- Shut off fuel (ref. TM 9-2359-311-10).
- Dial 10 into TEST SELECT, press and release TEST button.
- Crank engine and watch the display.
- Is the minimum cranking speed 100 RPM?
YES
NO
Go to step 2, FIGURE 2, SHEET 5.
Go to NG 80, FIGURE 2, SHEET 13.

NG 30 **Continued**

2 CHECK FUEL SUPPLY:
- Verify that there is fuel in the tank (ref. TM 9-2350-311-10).
- If fuel filters have been changed or fuel tank has run dry, notify Direct Support Maintenance.
- Drain any water from the primary fuel filter (ref. p. 6-14) and continue to drain until fuel appears.
- Check for kinked, flattened, or broken fuel lines from the tank to the filters and engine (ref. p. 6-2).
- Check for blockage in quick disconnect fittings (ref. p. 6-2).
- Check pumps (ref. p. 6-12) to make sure they are in working order.
- Check fuel shut-off (ref. p. 5-16).

WARNING

ON SOME VEHICLES WHICH HAVE THE MASTER SWITCH IN THE NEGATIVE BATTERY CABLE, SPARKING MAY OCCUR IF THE VTM CASE TOUCHES THE VEHICLE WHILE THE MASTER SWITCH IS OFF AND THE STE/ICE POWER IS ON. THIS SPARKING IN THE PRESENCE OF FUEL AND/OR VAPORS WHICH RESULT FROM DISCONNECTING FUEL LINES PRESENTS A POTENTIAL HAZZARD TO PERSONNEL. YOU CAN PREVENT THIS HAZZARD BY SETTING THE VTM DOWN SO THAT ONLY THE RUBBER BUMPERS TOUCH THE VEHICLE OR BY DOING ALL TESTING WITH THE MASTER SWITCH ON.

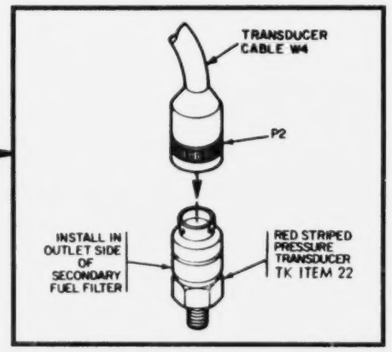
CAUTION

Before opening the fuel line, make sure that the area around the fuel line is clean. Operation of engine with red striped transducer (TK22) installed could damage transducer. During this test, be prepared to shut off fuel immediately if engine starts. Remove transducer before attempting to start the engine.

FIGURE 2. SHEET 5 OF 32

3 INSTALL TRANSDUCER:

- Install pressure transducer (red striped - TK 22) in the outlet side of the secondary fuel filter (ref. p. 6-16).
- Connect P1 of transducer cable W4 to J3 on the VTM.
- Connect P2 of the transducer cable W4 to the connector on the transducer.



- Dial 49 into TEST SELECT.
- Press and hold TEST until CAL message appears on display.
- Release TEST button.
- Wait for offset value to appear on the display.

PROMPTING MESSAGE

- Is the offset value within the limits of -4 to +4?

YES

Go to step 4, FIGURE 2, SHEET 7.

NO

Go to TM 9-4910-571-12&P for offset fault isolation.

NG 30 **Continued**

4

MEASURE FUEL PRESSURE DURING CRANKING:
- Turn on fuel and accessory switch.
- Press and release TEST button.
- Crank engine and watch readout display.

- Is the minimum fuel pressure displayed greater than 4 PSI?

NO

YES

- Remove the red stripe pressure transducer.
- Refer to TM 9-2350-311-10 for proper operation of engine fuel shut-off.
- Check for restricted air intake.
- If engine does not start and weather is cold, refer to TM 9-2350-311-10 to check cold start devices.
- If still no start, notify Direct Support Maintenance.

NOTE

After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

FIGURE 2. SHEET 7 OF 32

CAUTION

Remove transducer before attempting to start engine.

- Move pressure transducer to inlet side of the primary fuel filter (ref. p. 6-14).
- Turn on master switch.
- Crank engine and watch readout display.

- Is the fuel pressure greater than 4 PSI?

CAUTION

Remove transducer before attempting to start engine.

YES

- Replace fuel filters (ref. p. 6-14 and 6-16).
- Attempt to start the engine.
- If still no start, return to step 2 (FIGURE 2, SHEET 5).

NO

- Check electrically driven fuel pump (ref. p. 6-20). Replace as necessary.
- Check engine driven fuel pump (ref. p. 6-18). Replace as necessary.
- Check for oil or fuel pressure switch in charging system.
- If operating in freezing tempertures, check fuel lines for ice blockage due to water accumulation or coagulation of fuel.
- Attempt to start the engine.
- If still no start, locate and repair blockage in fuel line (ref. p. 6-24).

NOTE

After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

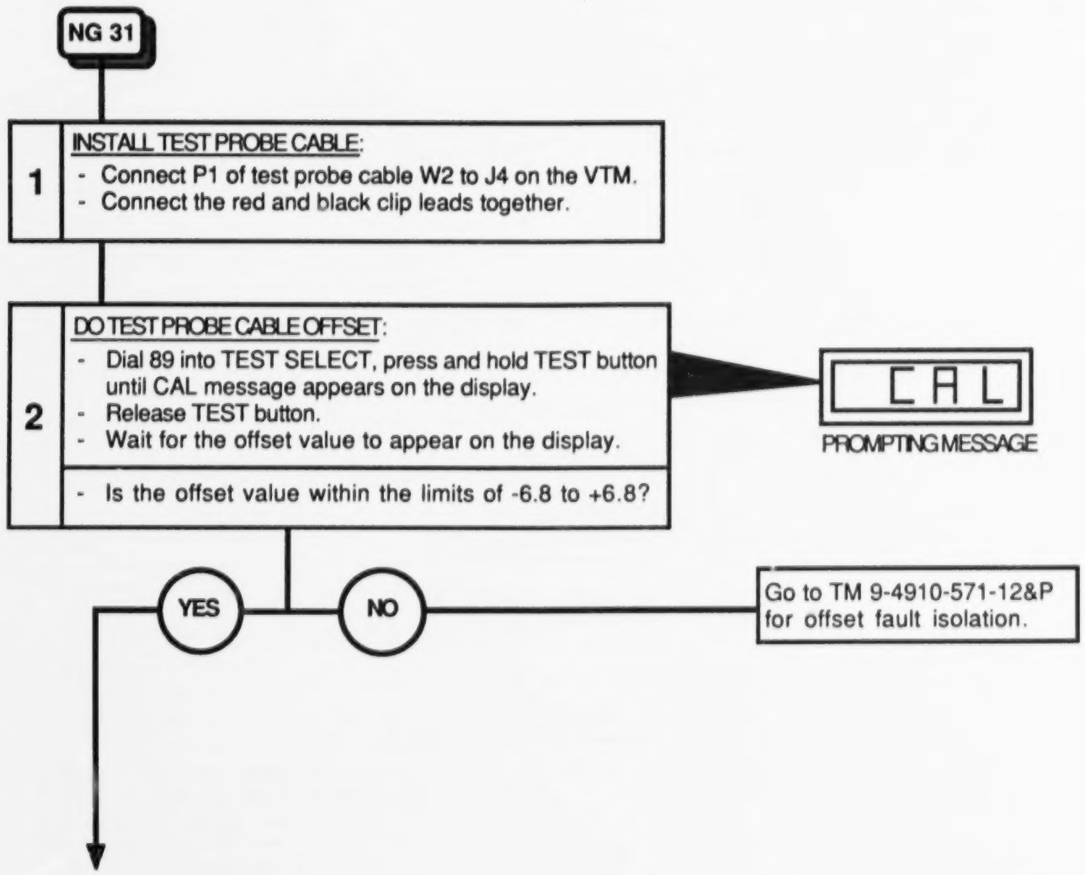

NG 31
1
INSTALL TEST PROBE CABLE:
- Connect P1 of test probe cable W2 to J4 on the VTM.
- Connect the red and black clip leads together.
2
DO TEST PROBE CABLE OFFSET:
- Dial 89 into TEST SELECT, press and hold TEST button until CAL message appears on the display.
- Release TEST button.
- Wait for the offset value to appear on the display.
- Is the offset value within the limits of -6.8 to +6.8?
CAL
PROMPTING MESSAGE
YES
NO
Go to TM 9-4910-571-12&P for offset fault isolation.

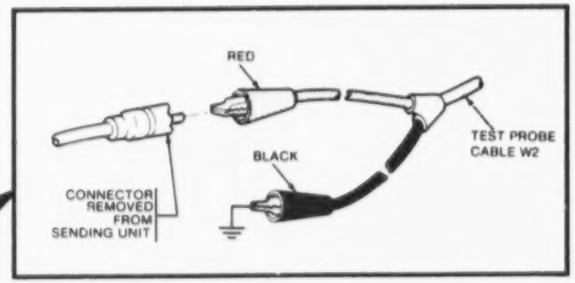
FIGURE 2. SHEET 9 OF 32

3

ISOLATE FAULT TO SENDING UNIT OR GAGE:

- Remove the wire from the sending unit of the suspect gage on the vehicle.
- Connect the red clip lead of W2 to the wire removed from the sending unit.
- Connect the black clip lead to a good ground.
- Press and release TEST button.
- Turn vehicle accessory switch ON.

- Does the VTM indicate at or near battery voltage (24 VDC)?



YES → Replace sending unit.

NO → Check and isolate fault to wiring harness or gage. If multimeter is needed, use VTM.

NOTE

After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

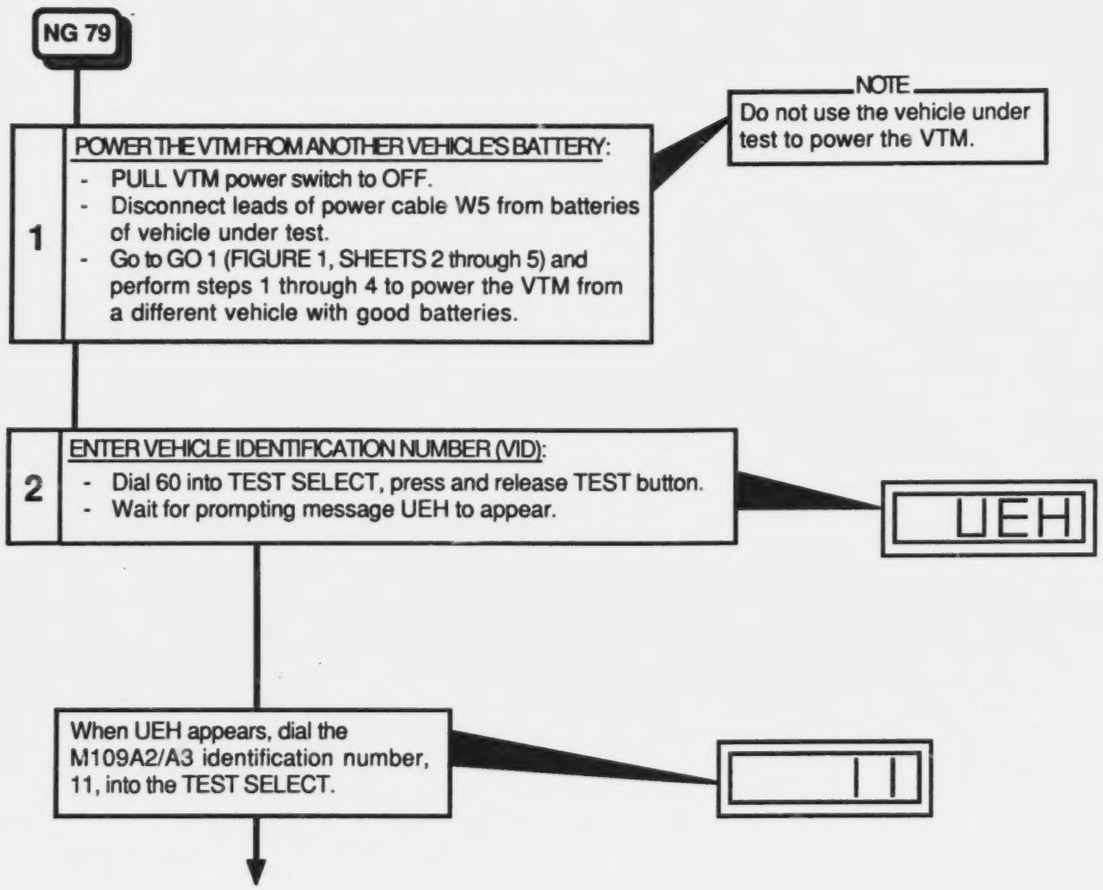
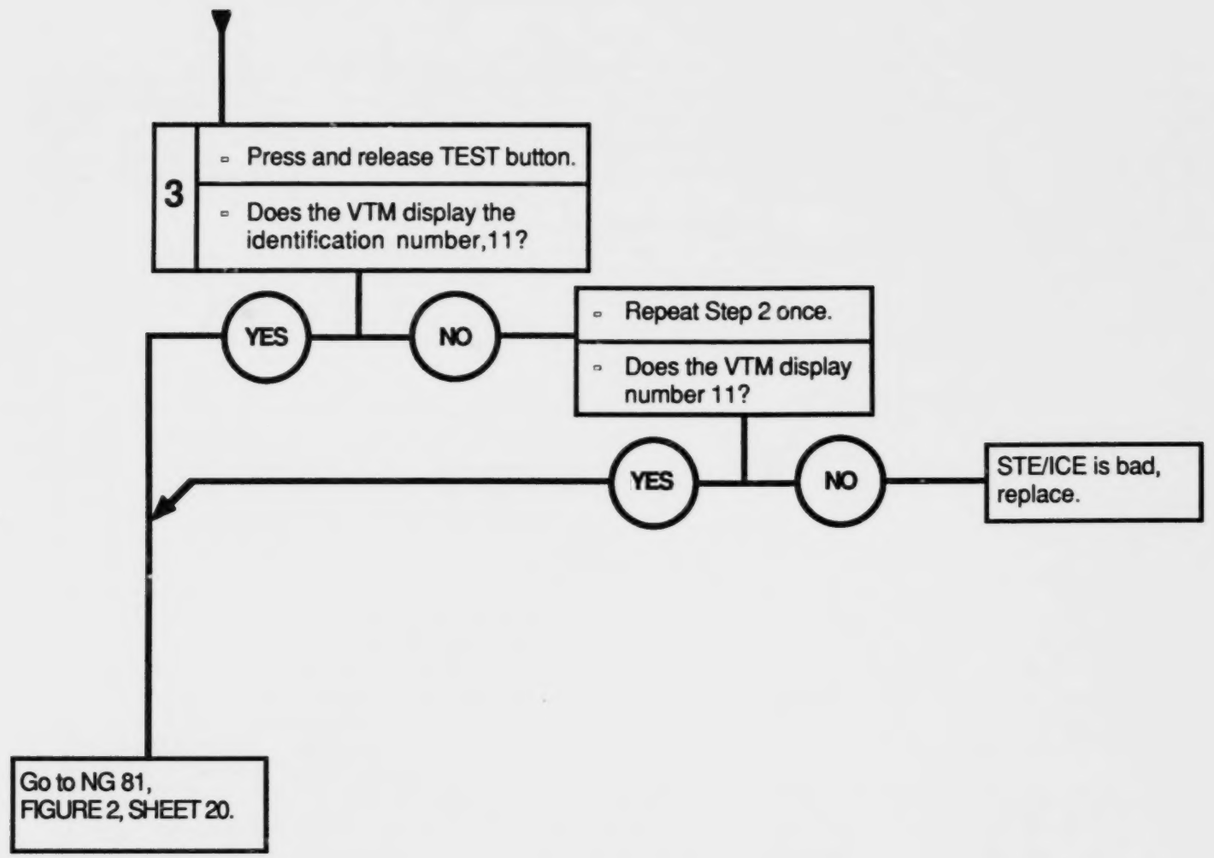

NG 79
NOTE
Do not use the vehicle under test to power the VTM.
1
POWER THE VTM FROM ANOTHER VEHICLE'S BATTERY:
- PULL VTM power switch to OFF.
- Disconnect leads of power cable W5 from batteries of vehicle under test.
- Go to GO 1 (FIGURE 1, SHEETS 2 through 5) and perform steps 1 through 4 to power the VTM from a different vehicle with good batteries.
2
ENTER VEHICLE IDENTIFICATION NUMBER (VID):
- Dial 60 into TEST SELECT, press and release TEST button.
- Wait for prompting message UEH to appear.
UEH
When UEH appears, dial the M109A2/A3 identification number, 11, into the TEST SELECT.
11

FIGURE 2. SHEET 11 OF 32


3
Press and release TEST button.
Does the VTM display the identification number,11?
YES
NO
Repeat Step 2 once.
Does the VTM display number 11?
YES
NO
STE/ICE is bad, replace.
Go to NG 81, FIGURE 2, SHEET 20.

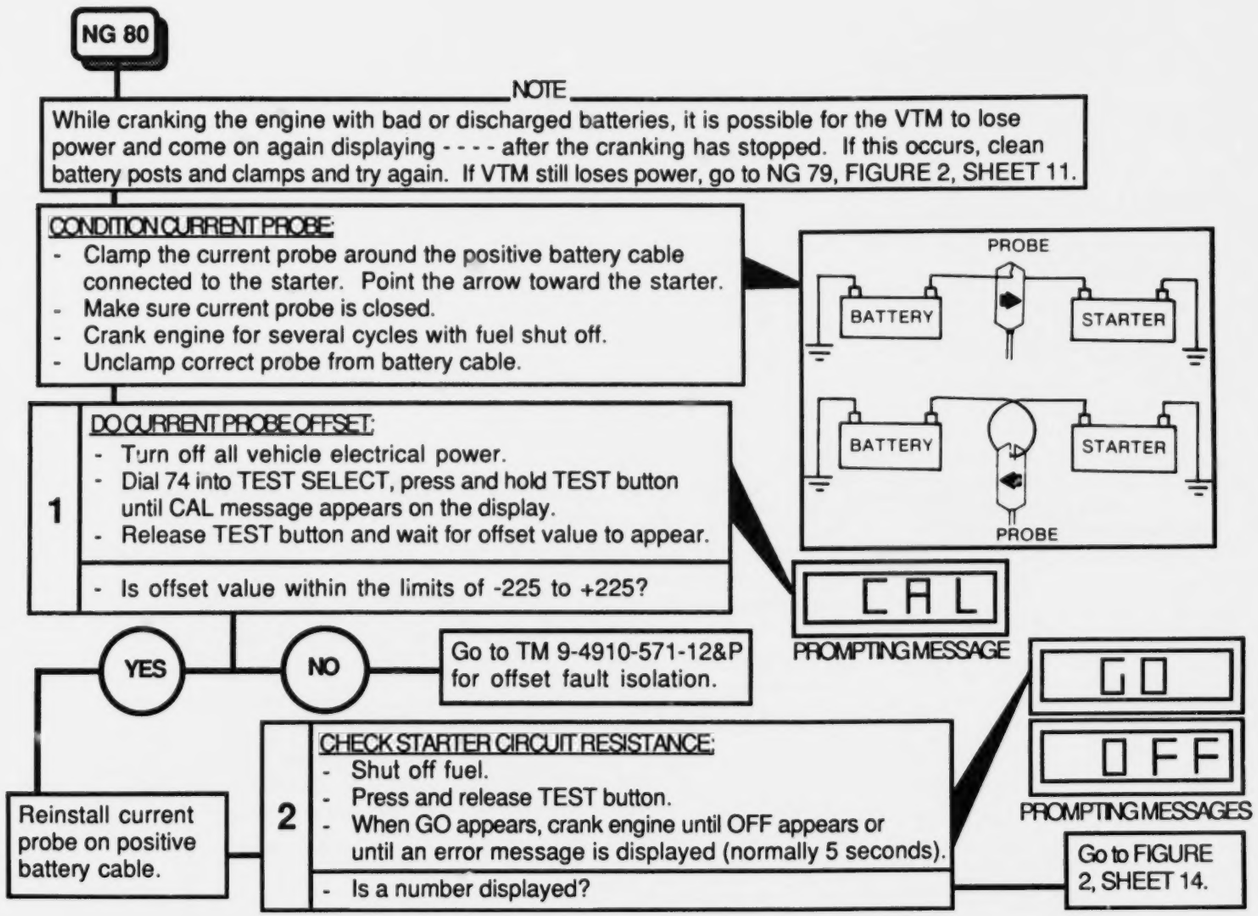
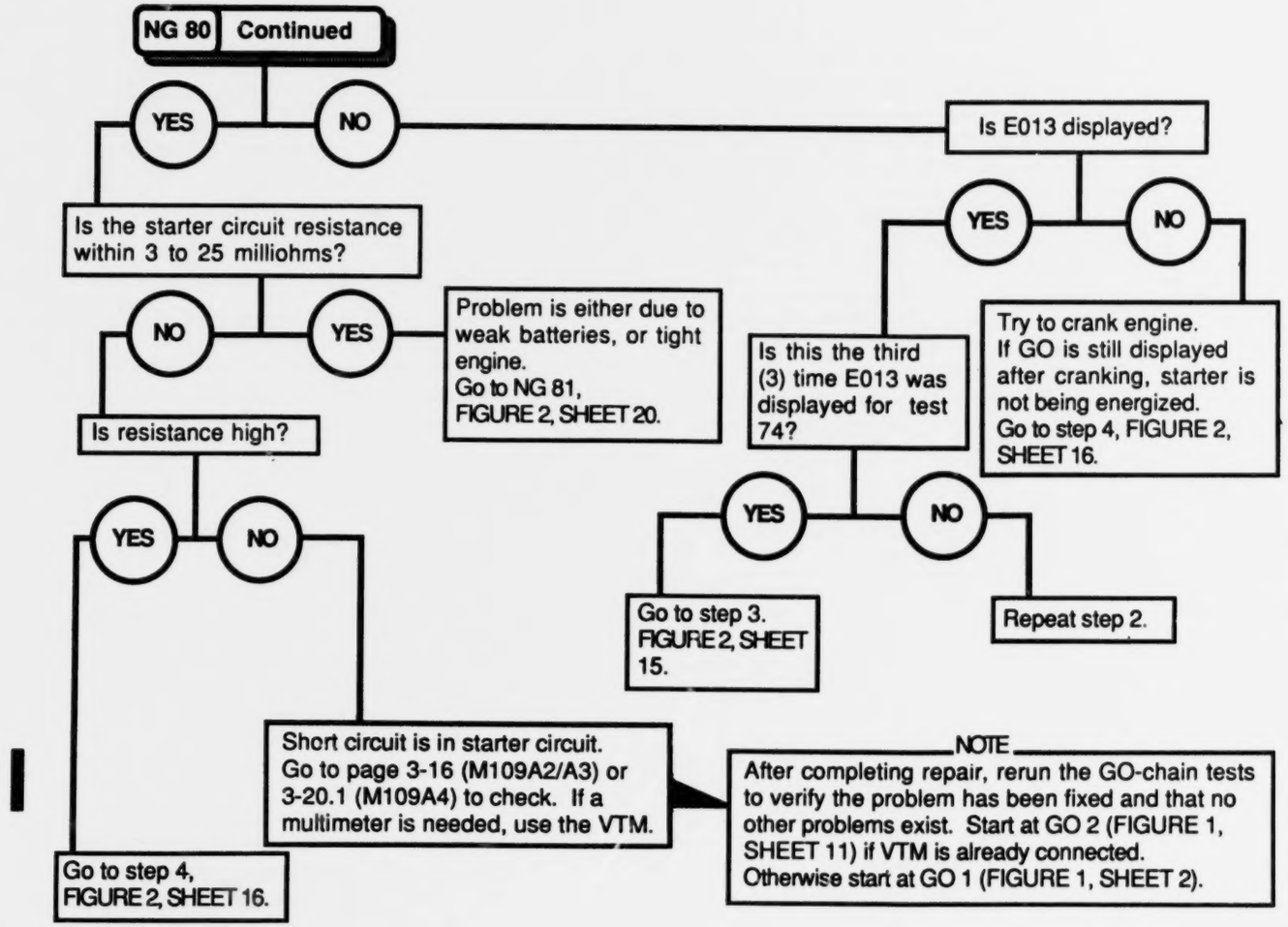

NG 80
NOTE
While cranking the engine with bad or discharged batteries, it is possible for the VTM to lose power and come on again displaying - - - - after the cranking has stopped. If this occurs, clean battery posts and clamps and try again. If VTM still loses power, go to NG 79, FIGURE 2, SHEET 11.
CONDITION CURRENT PROBE:
- Clamp the current probe around the positive battery cable connected to the starter. Point the arrow toward the starter.
- Make sure current probe is closed.
- Crank engine for several cycles with fuel shut off.
- Unclamp correct probe from battery cable.
PROBE
BATTERY
STARTER
BATTERY
STARTER
PROBE
1
DO CURRENT PROBE OFFSET:
- Turn off all vehicle electrical power.
- Dial 74 into TEST SELECT, press and hold TEST button until CAL message appears on the display.
- Release TEST button and wait for offset value to appear.
- Is offset value within the limits of -225 to +225?
CAL
PROMPTING MESSAGE
YES
NO
Go to TM 9-4910-571-12&P for offset fault isolation.
GO
OFF
PROMPTING MESSAGES
Reinstall current probe on positive battery cable.
2
CHECK STARTER CIRCUIT RESISTANCE:
- Shut off fuel.
- Press and release TEST button.
- When GO appears, crank engine until OFF appears or until an error message is displayed (normally 5 seconds).
- Is a number displayed?
Go to FIGURE 2, SHEET 14.

FIGURE 2. SHEET 13 OF 32


NG 80 Continued
YES
NO
Is the starter circuit resistance within 3 to 25 milliohms?
NO
YES
Problem is either due to weak batteries, or tight engine.
Go to NG 81, FIGURE 2, SHEET 20.
Is resistance high?
YES
NO
Go to step 4, FIGURE 2, SHEET 16.
Short circuit is in starter circuit.
Go to page 3-16 (M109A2/A3) or 3-20.1 (M109A4) to check. If a multimeter is needed, use the VTM.
Is E013 displayed?
YES
NO
Is this the third (3) time E013 was displayed for test 74?
Try to crank engine.
If GO is still displayed after cranking, starter is not being energized.
Go to step 4, FIGURE 2, SHEET 16.
YES
NO
Go to step 3. FIGURE 2, SHEET 15.
Repeat step 2.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

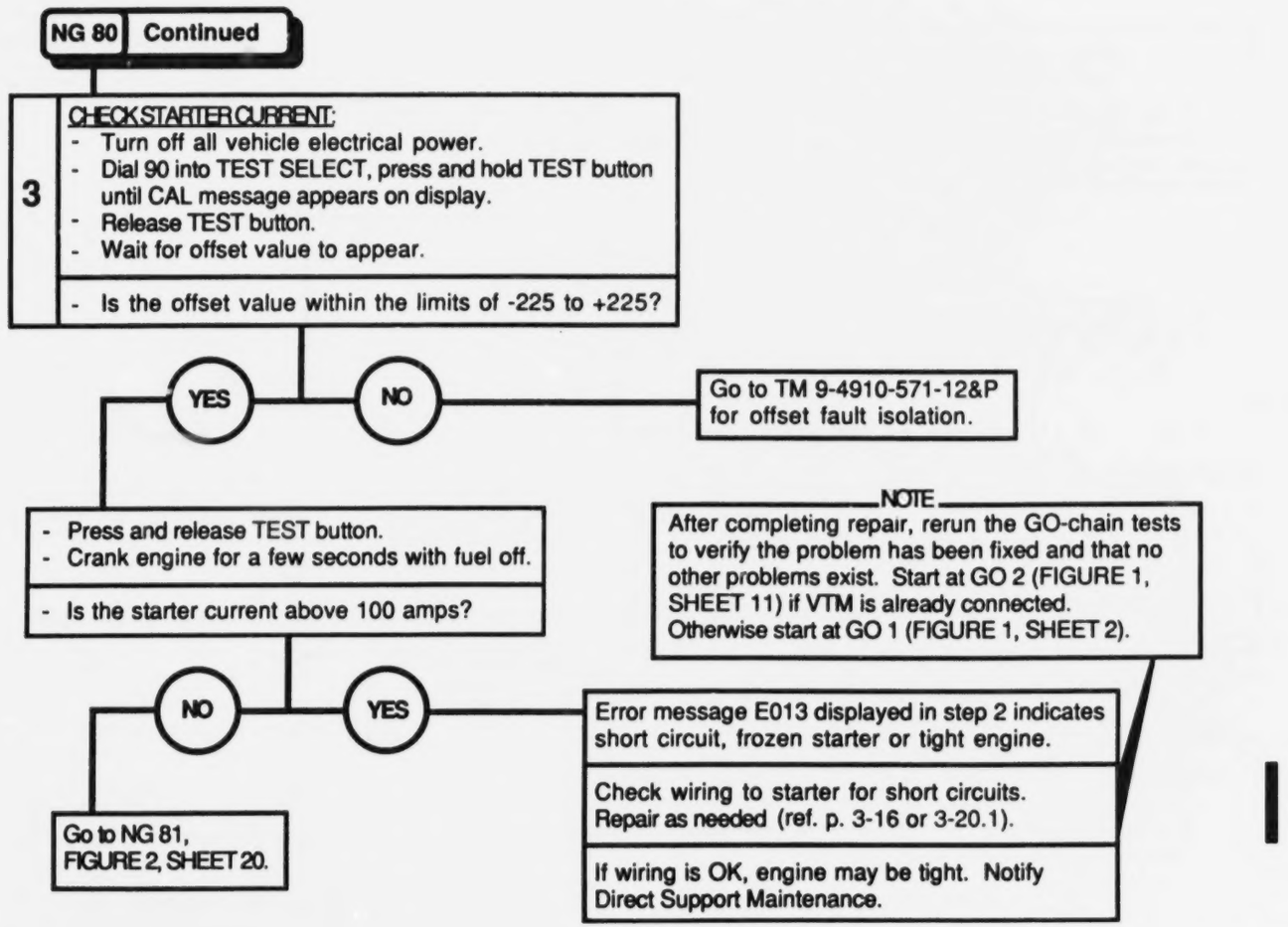

NG 80 Continued
3
CHECK STARTER CURRENT:
- Turn off all vehicle electrical power.
- Dial 90 into TEST SELECT, press and hold TEST button until CAL message appears on display.
- Release TEST button.
- Wait for offset value to appear.
- Is the offset value within the limits of -225 to +225?
YES
NO
Go to TM 9-4910-571-12&P for offset fault isolation.
- Press and release TEST button.
- Crank engine for a few seconds with fuel off.
- Is the starter current above 100 amps?
NO
YES
Go to NG 81, FIGURE 2, SHEET 20.
Error message E013 displayed in step 2 indicates short circuit, frozen starter or tight engine.
Check wiring to starter for short circuits. Repair as needed (ref. p. 3-16 or 3-20.1).
If wiring is OK, engine may be tight. Notify Direct Support Maintenance.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

FIGURE 2. SHEET 15 OF 32

NG 80 Continued

4

CHECK STARTER SOLENOID:
- Attempt to start engine while listening for clicking of starter solenoid.
- Does the starter solenoid click?

YES

NO → Go to page 3-16 to check switches, wiring, relays and circuit breakers to starter solenoid. If a multimeter is needed, use the VTM.

5

INSTALL TEST PROBE CABLE:
- Connect P1 of test probe cable W2 to J4 on VTM.
- Connect the red and black clip together.

6

DO TEST PROBE CABLE OFFSET:
- Dial 89 into TEST SELECT, press and hold TEST button until CAL message appears on the display.
- Release TEST button.
- Wait for the offset value to appear on the display.
- Is the offset value within the limits of -6.8 to +6.8?

CAL

PROMPTING MESSAGE

YES

NO → Go to TM 9-4910-571-12&P for offset fault isolation.

Go to step 7.
FIGURE 2, SHEET 17.

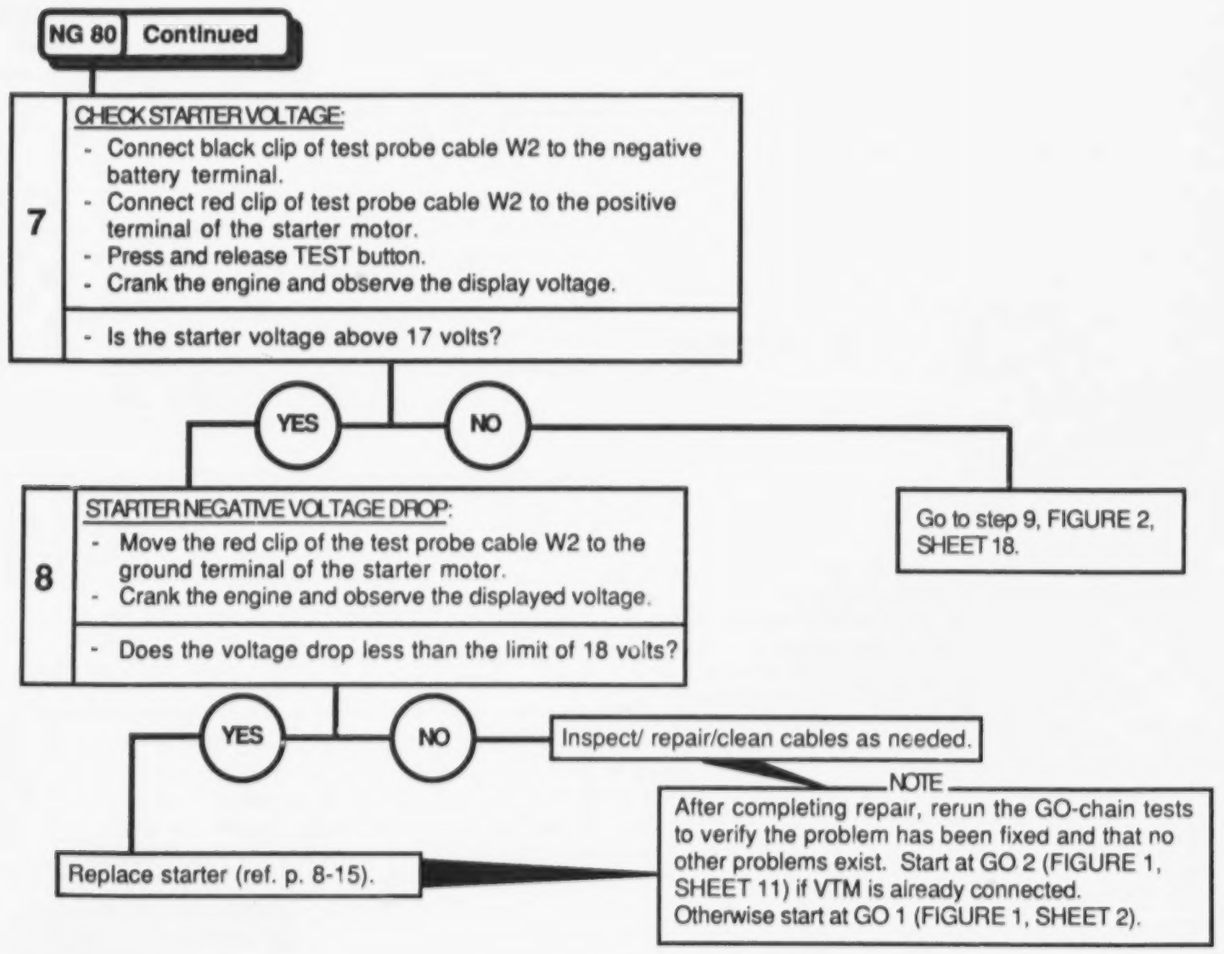

NG 80 Continued
7
CHECK STARTER VOLTAGE:
- Connect black clip of test probe cable W2 to the negative battery terminal.
- Connect red clip of test probe cable W2 to the positive terminal of the starter motor.
- Press and release TEST button.
- Crank the engine and observe the display voltage.
- Is the starter voltage above 17 volts?
YES
NO
8
STARTER NEGATIVE VOLTAGE DROP:
- Move the red clip of the test probe cable W2 to the ground terminal of the starter motor.
- Crank the engine and observe the displayed voltage.
- Does the voltage drop less than the limit of 18 volts?
YES
NO
Go to step 9, FIGURE 2, SHEET 18.
Inspect/ repair/clean cables as needed.
Replace starter (ref. p. 8-15).
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

FIGURE 2. SHEET 17 OF 32

NG 80 Continued

9

CHECK STARTER SOLENOID VOLTAGE:
- Move red clip of test probe cable W2 to positive terminal of starter solenoid.
- Crank the engine and observe the displayed voltage.

- Is the starter solenoid voltage above 18 volts?

YES

If starter circuit resistance was high in step 9, go to step 11, FIGURE 2, SHEET 19.

If GO message occurred during starter circuit resistance test in step 2, check switches and wiring to solenoid. If OK, replace solenoid/starter.

Go to step 11, FIGURE 2, SHEET 19.

NO

10

CHECK BATTERY VOLTAGE WHILE CRANKING:
- Dial 67 into TEST SELECT, press and release TEST button.
- Crank the engine and observe the display.

- Was the battery voltage above 18 volts while cranking?

YES

Go to page 3-16 (M109A2/A3) or 3-20.1 (M109A4) to check switches and wiring to starter solenoid. Notify Support Maintenance.

NO

Go to NG 81, FIGURE 2, SHEET 20.

NOTE

After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

NG 80 **Continued**

NOTE

The drop limits across a connection should be less than 0.1 volt and the drop across a cable should be less than 0.2 volts.

Check the voltage drop across the solenoid, all cables and connections in the positive side of the starter circuit.

11

MEASURE VOLTAGE DROP:

- Dial 89 into TEST SELECT.
- Connect the clip leads of test probe cable W2 across the part (solenoid, cable, or connection) to be measured.
- Press and release TEST button.
- Engage the starter.
- Compare the voltage drop on display with the guidelines mentioned in the above NOTE.

- Repair or replace the defective part tested.

NOTE

After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

FIGURE 2. SHEET 19 OF 32

NG 81

NOTE

Each battery is tested individually. During this test, the fuel supply must be shut off to keep engine from starting.

1 INSTALL TEST PROBE W2:

- Connect P1 of W2 to J4 of the VTM.
- Connect red clip of cable W2 to positive post of battery being tested.
- Connect black clip of cable W2 to negative post of battery being tested.

2 CONDITION CURRENT PROBE:

- Clamp current probe, TK Item 11, around battery cable which connects the series pair of batteries containing the battery to be tested. Make sure current probe is closed.
- Point arrow on current probe toward the negative post as shown in FIGURE 3, SHEET 7.
- Attempt to crank the engine for several cycles with the fuel shut off.

- Turn off all vehicle electrical power.
- Dial 79 into TEST SELECT, press and hold TEST button until CAL message appears on display.
- Release TEST button.
- Wait for offset value to appear.

PROMPTING MESSAGE

- Is the offset value within the limits of -225 to +225?

YES → Go to step 3, FIGURE 2, SHEET 21.

NO → Go to TM 9-4910-571-12&P for offset fault isolation.

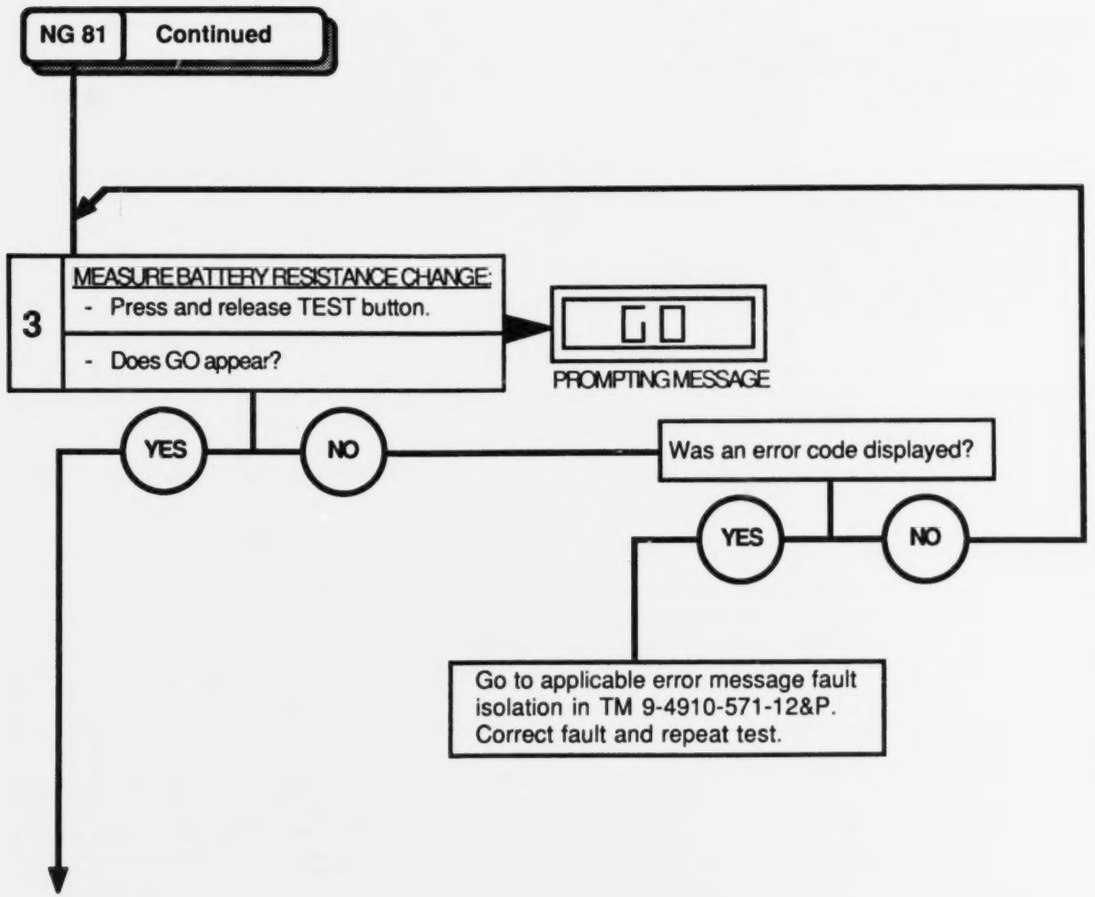
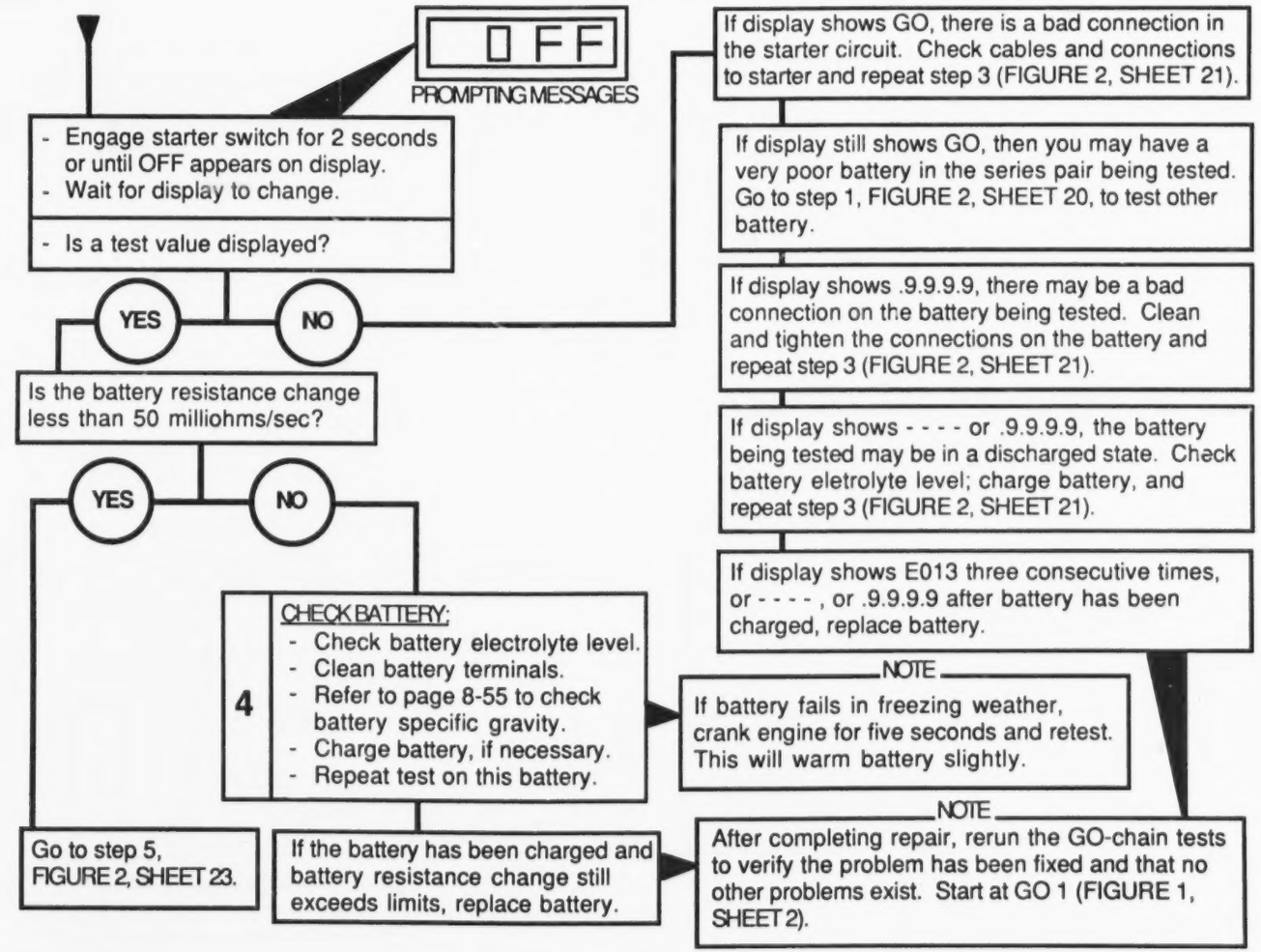


FIGURE 2. SHEET 21 OF 32


OFF
PROMPTING MESSAGES
- Engage starter switch for 2 seconds or until OFF appears on display.
- Wait for display to change.
- Is a test value displayed?
YES
NO
Is the battery resistance change less than 50 milliohms/sec?
YES
NO
Go to step 5, FIGURE 2, SHEET 23.
4
CHECK BATTERY:
- Check battery electrolyte level.
- Clean battery terminals.
- Refer to page 8-55 to check battery specific gravity.
- Charge battery, if necessary.
- Repeat test on this battery.
If the battery has been charged and battery resistance change still exceeds limits, replace battery.
If display shows GO, there is a bad connection in the starter circuit. Check cables and connections to starter and repeat step 3 (FIGURE 2, SHEET 21).
If display still shows GO, then you may have a very poor battery in the series pair being tested. Go to step 1, FIGURE 2, SHEET 20, to test other battery.
If display shows .9.9.9.9, there may be a bad connection on the battery being tested. Clean and tighten the connections on the battery and repeat step 3 (FIGURE 2, SHEET 21).
If display shows - - - - or .9.9.9.9, the battery being tested may be in a discharged state. Check battery eletrolyte level; charge battery, and repeat step 3 (FIGURE 2, SHEET 21).
If display shows E013 three consecutive times, or - - - - , or .9.9.9.9 after battery has been charged, replace battery.
NOTE
If battery fails in freezing weather, crank engine for five seconds and retest. This will warm battery slightly.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 1 (FIGURE 1, SHEET 2).

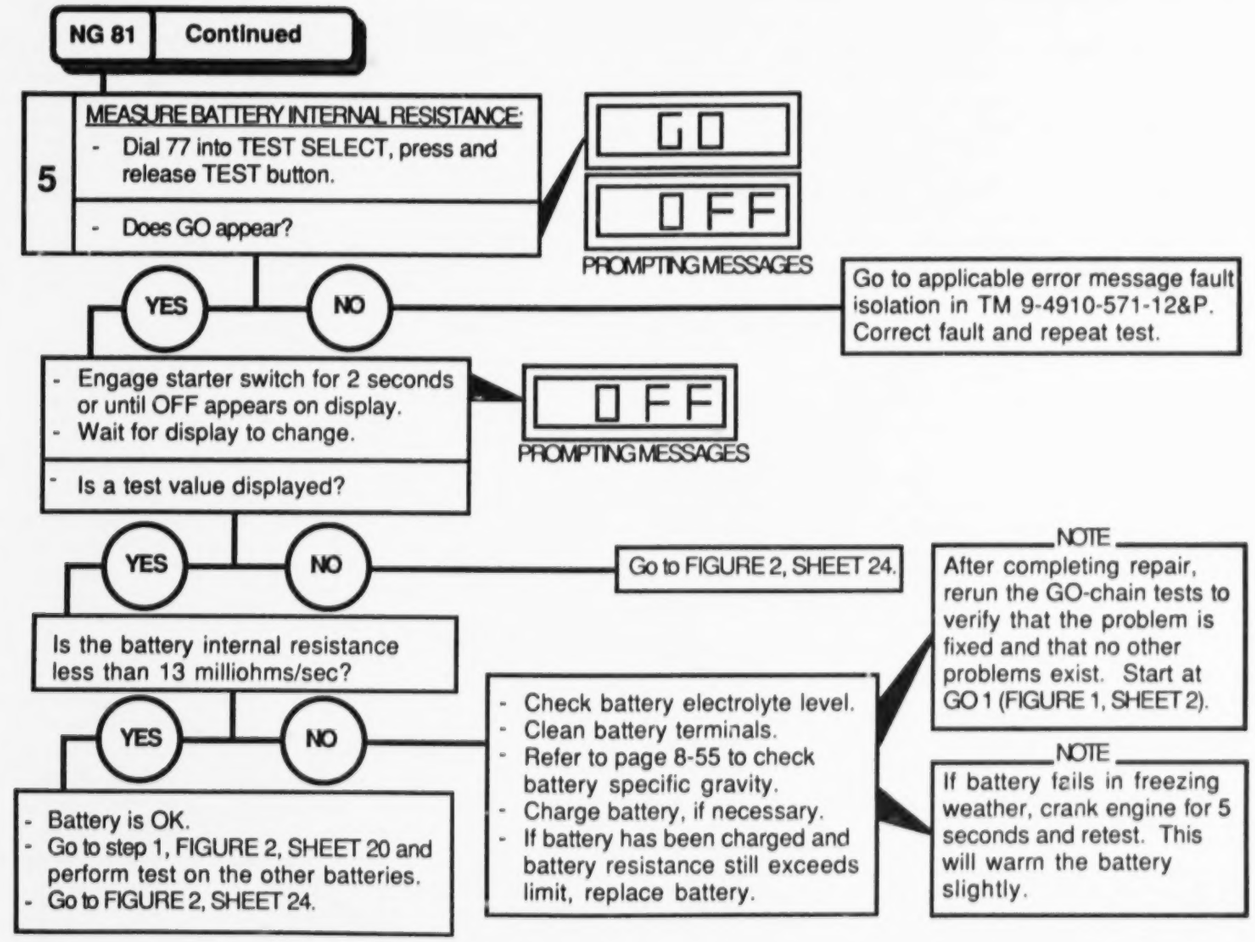

NG 81 Continued
5
MEASURE BATTERY INTERNAL RESISTANCE:
- Dial 77 into TEST SELECT, press and release TEST button.
- Does GO appear?
GO
OFF
PROMPTING MESSAGES
YES
NO
Go to applicable error message fault isolation in TM 9-4910-571-12&P. Correct fault and repeat test.
- Engage starter switch for 2 seconds or until OFF appears on display.
- Wait for display to change.
OFF
PROMPTING MESSAGES
- Is a test value displayed?
YES
NO
Go to FIGURE 2, SHEET 24.
Is the battery internal resistance less than 13 milliohms/sec?
YES
NO
- Battery is OK.
- Go to step 1, FIGURE 2, SHEET 20 and perform test on the other batteries.
- Go to FIGURE 2, SHEET 24.
- Check battery electrolyte level.
- Clean battery terminals.
- Refer to page 8-55 to check battery specific gravity.
- Charge battery, if necessary.
- If battery has been charged and battery resistance still exceeds limit, replace battery.
NOTE
After completing repair, rerun the GO-chain tests to verify that the problem is fixed and that no other problems exist. Start at GO 1 (FIGURE 1, SHEET 2).
NOTE
If battery fails in freezing weather, crank engine for 5 seconds and retest. This will warm the battery slightly.

FIGURE 2. SHEET 23 OF 32

NG 81 | **Continued**

If display shows GO, there is a bad connection in the starter circuit. Check cables and connections to starter and retest.

If display still shows GO, then you may have a very poor battery in the series pair being tested. Test each battery individually. Go to step 1, FIGURE 2, SHEET 20, to test other battery.

If display shows .9.9.9.9, there may be a bad connection on the battery being tested. Clean and tighten the connections on the battery and retest.

If display shows E013 or .9.9.9.9, the battery being tested may be in a discharged state. Check battery eletrolyte level; charge battery, and retest.

If display shows E013 three consecutive times, or - - - - , or .9.9.9.9 after battery has been charged, replace battery.

NOTE

After completing repair, rerun the GO- chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 1 (FIGURE 1, SHEET 2).

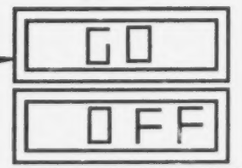
NG 81 **Continued**

- Clamp current probe, TK Item 11, battery cable connected to the starter.
- Point arrow on probe toward the starter.
- Make sure the current probe is closed.

6

MEASURE CURRENT - FIRST PEAK:
- Dial 76 into TEST SELECT, press and release TEST button.
- Wait for prompting message GO to appear on display.
- When GO appears, shut off fuel and engage starter switch for 5 seconds or until OFF or an error message is displayed.

- Is a number displayed?



PROMPTING MESSAGES

YES / NO

NOTE
After completing repair, rerun the GO-chain tests to verify that the problem is fixed and that no other problems exist. Start at GO 1 (FIGURE 1, SHEET 2).

- Check all batteries electrolyte levels.
- Clean batteries terminals.
- Go to 8-55 to check batteries specific gravities.
- Charge batteries, if necessary.

Is E013 displayed?

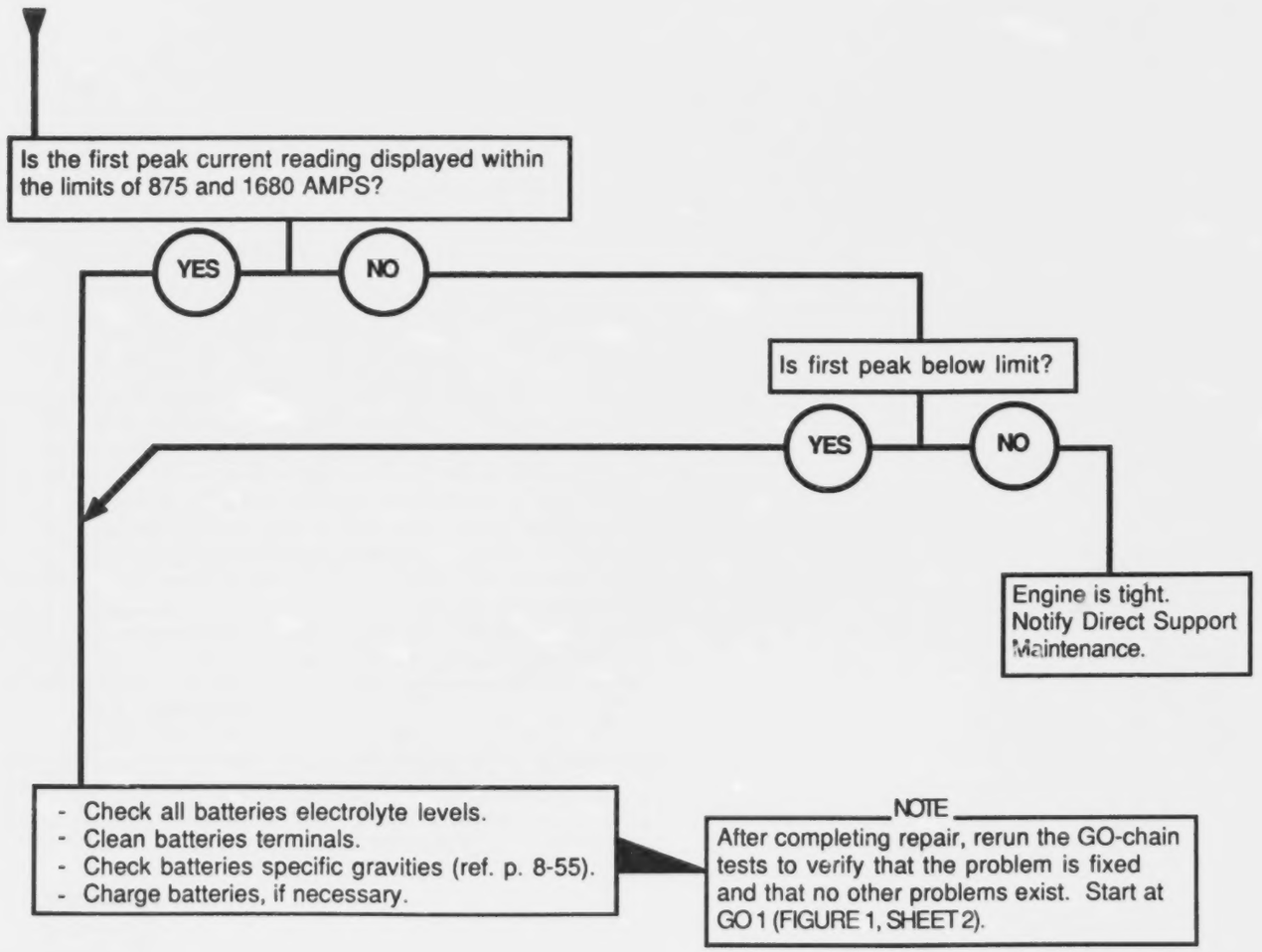
NO / YES

Is this the third time E013 was displayed for test 76?

YES / NO

Repeat step 2, FIGURE 2, SHEET 20.

FIGURE 2. SHEET 25 OF 32


Is the first peak current reading displayed within the limits of 875 and 1680 AMPS?
YES
NO
Is first peak below limit?
YES
NO
Engine is tight. Notify Direct Support Maintenance.
- Check all batteries electrolyte levels.
- Clean batteries terminals.
- Check batteries specific gravities (ref. p. 8-55).
- Charge batteries, if necessary.
NOTE
After completing repair, rerun the GO-chain tests to verify that the problem is fixed and that no other problems exist. Start at GO 1 (FIGURE 1, SHEET 2).

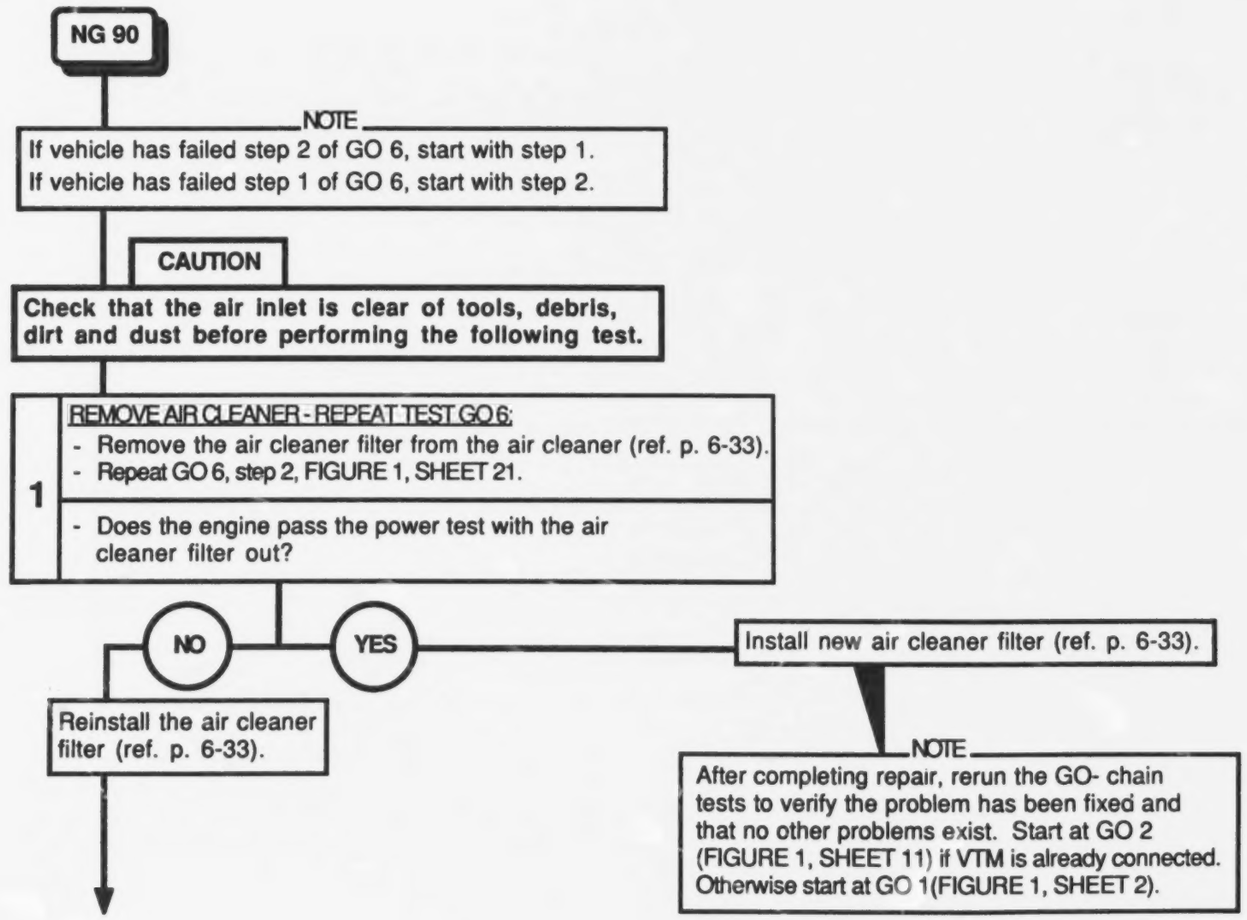
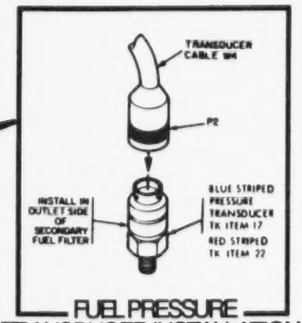

NG 90
NOTE
If vehicle has failed step 2 of GO 6, start with step 1.
If vehicle has failed step 1 of GO 6, start with step 2.
CAUTION
Check that the air inlet is clear of tools, debris, dirt and dust before performing the following test.
1
REMOVE AIR CLEANER - REPEAT TEST GO 6:
- Remove the air cleaner filter from the air cleaner (ref. p. 6-33).
- Repeat GO 6, step 2, FIGURE 1, SHEET 21.
- Does the engine pass the power test with the air cleaner filter out?
NO
YES
Reinstall the air cleaner filter (ref. p. 6-33).
Install new air cleaner filter (ref. p. 6-33).
NOTE
After completing repair, rerun the GO- chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1(FIGURE 1, SHEET 2).

FIGURE 2. SHEET 27 OF 32

2 INSTALL TRANSDUCER:

- Install blue striped transducer, TK Item 17, in the outlet side of the secondary fuel filter.
- Connect P1 of transducer cable W4 to J3 on the VTM.
- Connect P2 of cable W4 to the connector on the transducer.


TRANSDUCER CABLE W4
P2
INSTALL IN OUTLET SIDE OF SECONDARY FUEL FILTER
BLUE STRIPED PRESSURE TRANSDUCER TK ITEM 17
RED STRIPED TK ITEM 22
FUEL PRESSURE TRANSDUCER INSTALLATION

WARNING

ON SOME VEHICLES WHICH HAVE THE MASTER SWITCH IN THE NEGATIVE BATTERY CABLE, SPARKING MAY OCCUR IF THE VTM CASE TOUCHES THE VEHICLE WHILE THE MASTER SWITCH IS OFF AND THE STE/ICE POWER IS ON. THIS SPARKING IN THE PRESENCE OF FUEL AND/OR VAPORS WHICH RESULT FROM DISCONNECTING FUEL LINES PRESENTS A POTENTIAL HAZZARD TO PERSONNEL. YOU CAN PREVENT THIS HAZZARD BY SETTING THE VTM DOWN SO THAT ONLY THE RUBBER BUMPERS TOUCH THE VEHICLE OR BY DOING ALL TESTING WITH THE MASTER SWITCH ON.

- Dial 50 into TEST SELECT, press and hold TEST button until CAL message appears on display.
- Release TEST button.
- Wait for offset value to appear on display.

- Is the offset value within the range of -150 to+150?

YES → Go to step 3, FIGURE 2, SHEET 29.

NO → Go to TM 9-4910-571-12&P for offset fault isolation.

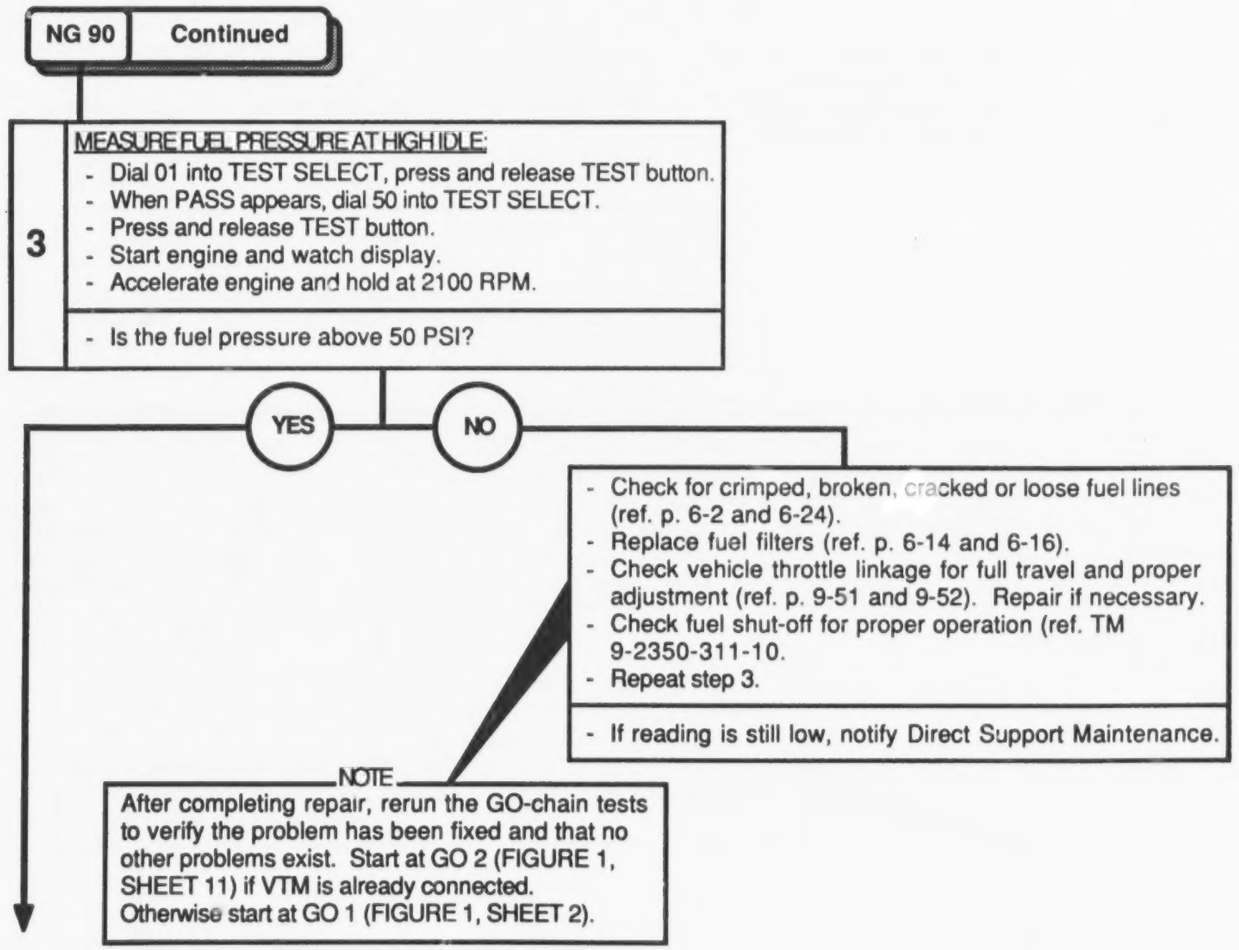
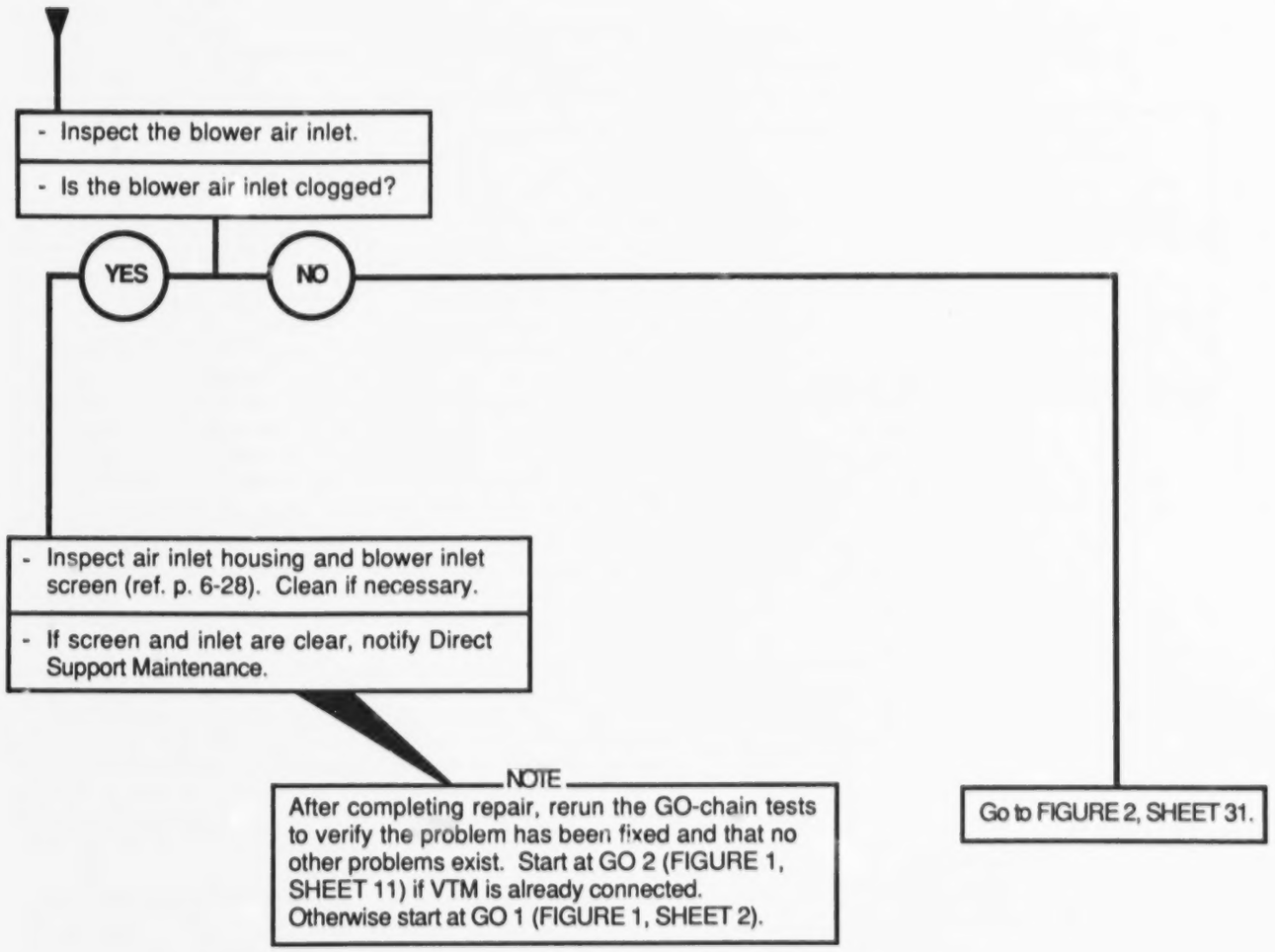

NG 90
Continued
3
MEASURE FUEL PRESSURE AT HIGH IDLE:
- Dial 01 into TEST SELECT, press and release TEST button.
- When PASS appears, dial 50 into TEST SELECT.
- Press and release TEST button.
- Start engine and watch display.
- Accelerate engine and hold at 2100 RPM.
- Is the fuel pressure above 50 PSI?
YES
NO
- Check for crimped, broken, cracked or loose fuel lines (ref. p. 6-2 and 6-24).
- Replace fuel filters (ref. p. 6-14 and 6-16).
- Check vehicle throttle linkage for full travel and proper adjustment (ref. p. 9-51 and 9-52). Repair if necessary.
- Check fuel shut-off for proper operation (ref. TM 9-2350-311-10.
- Repeat step 3.
- If reading is still low, notify Direct Support Maintenance.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

FIGURE 2. SHEET 29 OF 32


- Inspect the blower air inlet.
- Is the blower air inlet clogged?
YES
NO
- Inspect air inlet housing and blower inlet screen (ref. p. 6-28). Clean if necessary.
- If screen and inlet are clear, notify Direct Support Maintenance.
NOTE
After completing repair, rerun the GO-chain tests to verify the problem has been fixed and that no other problems exist. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).
Go to FIGURE 2, SHEET 31.

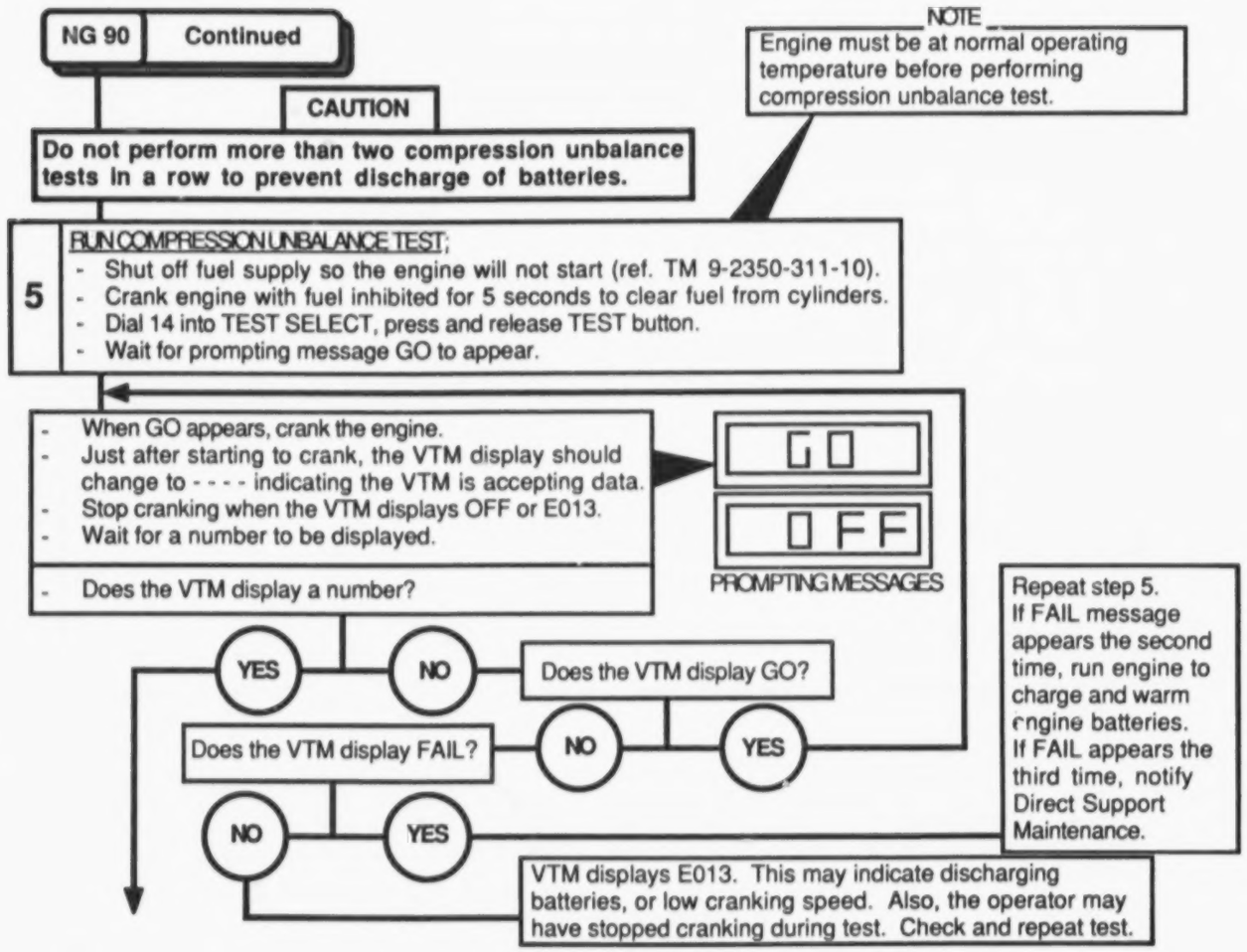
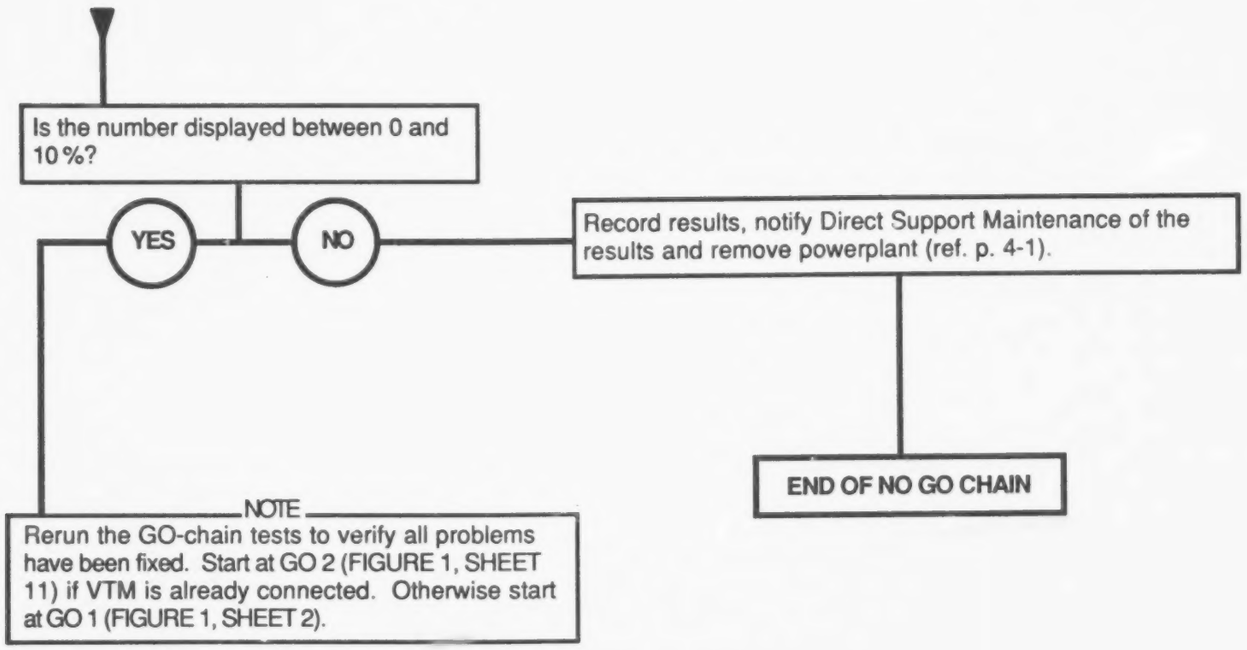

NG 90 Continued
NOTE
Engine must be at normal operating temperature before performing compression unbalance test.
CAUTION
Do not perform more than two compression unbalance tests in a row to prevent discharge of batteries.
5
RUN COMPRESSION UNBALANCE TEST;
- Shut off fuel supply so the engine will not start (ref. TM 9-2350-311-10).
- Crank engine with fuel inhibited for 5 seconds to clear fuel from cylinders.
- Dial 14 into TEST SELECT, press and release TEST button.
- Wait for prompting message GO to appear.
- When GO appears, crank the engine.
- Just after starting to crank, the VTM display should change to - - - - indicating the VTM is accepting data.
- Stop cranking when the VTM displays OFF or E013.
- Wait for a number to be displayed.
GO
OFF
PROMPTING MESSAGES
- Does the VTM display a number?
YES
NO
Does the VTM display GO?
NO
YES
Does the VTM display FAIL?
NO
YES
Repeat step 5.
If FAIL message appears the second time, run engine to charge and warm engine batteries.
If FAIL appears the third time, notify Direct Support Maintenance.
VTM displays E013. This may indicate discharging batteries, or low cranking speed. Also, the operator may have stopped cranking during test. Check and repeat test.

FIGURE 2. SHEET 31 OF 32


Is the number displayed between 0 and 10 %?
YES
NO
Record results, notify Direct Support Maintenance of the results and remove powerplant (ref. p. 4-1).
END OF NO GO CHAIN
NOTE
Rerun the GO-chain tests to verify all problems have been fixed. Start at GO 2 (FIGURE 1, SHEET 11) if VTM is already connected. Otherwise start at GO 1 (FIGURE 1, SHEET 2).

SECTION III. BATTERY TESTING

D-8. GENERAL

The STE/ICE battery test procedures allow the user to evaluate the condition and state of charge of vehicle/equipment batteries. These procedures use the battery internal resistance and battery resistance change measurements. Battery internal resistance evaluates the state of charge of the battery. Battery resistance change evaluates the battery condition.

Battery state of charge is a measure of the amount of energy stored in the battery. A fully charged battery contains the maximum amount of energy stored. If the battery fails the battery state of charge evaluation, the battery may be recharged to return the battery to full charge.

The battery condition is a measure of the battery's ability to accept and maintain a good charge. A battery in poor condition may be able to be fully recharged. However, a battery in poor condition with a full charge will lose its charge more quickly than a battery in good condition with a full charge. If a battery fails the battery condition evaluation, then the battery should be replaced.

The procedures for testing the M109 batteries are listed on three battery test cards. Each card describes procedures for evaluating the different combinations of batteries:

- Complete battery pack
- Series pair of batteries
- Individual batteries

D-9. BATTERY PACKS

A battery pack is the combination of four or more batteries in a particular circuit of a vehicle/equipment, i.e. the starting circuit. Testing the batteries in a pack evaluates the general condition of the pack as a whole. Note, the results of a battery pack test may be misleading. A single battery from a pack of four may be bad, even though the pack as a whole may pass the tests. This can happen if the other three batteries in the pack are in very good condition.

FIGURE 3. SHEET 1 OF 10

D-10. SERIES PAIRS

A series pair is one in which the negative terminal of one battery is connected by a cable to the positive terminal of another battery. This test configuration should be used when the battery pack test has failed and the user wants to further identify any bad battery pair.

NOTE

Testing both series pair yields a better evaluation than testing the pack as a whole.

D-11. INDIVIDUAL BATTERIES

An individual battery test refers to the process of testing one battery at a time. The battery could be part of a pack, a series pair, or a single battery. Test the batteries individually if a battery series pair failed the tests and it is desired to isolate to a single battery. Testing individual batteries gives the best evaluation.

D-12. DESCRIPTION OF TEST CARDS

The front of each test card has three sections. The top of the card explains how to connect the VTM to the batteries being tested. The middle part of the card describes the procedure to follow in order to evaluate the batteries. The bottom of the card contains illustrations showing typical vehicle hookups.

The back of each card also has three sections. The upper left-hand block lists the possible VTM displays and explains their meanings. This block suggests corrective action for the user. The right-hand side of the card contains battery test limits for three common military batteries. These limits may be used if the vehicle/equipment TM does not provide limits. The lower left-hand portion of the card contains a table showing how to apply the limits to evaluate the battery condition and state of charge.

D-13. PROCEDURE TO MAKE A BATTERY EVALUATION ON THE M109A2/A3/A4:

1. Use procedure on battery test card to hook-up VTM. The following information will enable the user to determine the correct tests to use:

a. Use test series 73 and 75 for the following conditions:

(1) Testing a battery pack that is also powering the VTM

(2) Testing a battery series pair that is also powering the VTM

(3) Testing an individual battery that is the only battery in the circuit and is powering the VTM

b. Use test series 77 and 79 for the following conditions:

(1) Testing a battery pack that is not powering the VTM

(2) Testing a battery series pair that is not powering the VTM

(3) Testing an individual battery that is not the only battery in a circuit or is not powering the VTM

2. Use test procedure on battery test card to complete evaluation of the M109A2/A3/A4 batteries.

a. Evaluate battery pack, battery series or individual condition using battery resistance change test (#75 or #79). Note the result.

b. Evaluate battery pack, battery series or individual state of charge using the battery internal resistance test (#73 or #77). Note the result.

c. Compare test results to limits on the back of the battery test cards. If the battery internal resistance test passes, then the batteries are fully charged. If the battery internal resistance test fails, then the batteries are not adequately charged. If the battery resistance change test passes, then the batteries are good and will retain their charge. If the battery resistance change test fails, then the batteries are bad and will not retain their charge.

d. If batteries are out of limits, perform one or all of the following:

(1) Check battery electrolyte level.

(2) Check battery connections and terminals. Clean or tighten if necessary. Check connections between VTM and batteries.

FIGURE 3. SHEET 3 OF 10

(3) Refer to page 2-42 to check battery specific gravity.

(4) Repeat battery resistance change and internal battery resistance tests one time. If internal battery resistance result (test #73 or #77) is out of limits, then charge batteries. If battery resistance change result (test #75 or #79) is out of limits, then continue testing to isolate bad batteries.

STE/ICE BATTERY PACK TEST CARD

The BATTERY INTERNAL RESISTANCE TEST (73 OR 77) evaluates the state of charge of the battery pack. The BATTERY RESISTANCE CHANGE TEST (75 or 79) evaluates whether the battery pack is good or bad, even if it is discharged. A good battery pack that is discharged may be recharged. A bad battery pack may hold a charge for a short time.

STE/ICE HOOKUP

1. The power to operate the STE/ICE VTM may be taken from the batteries being tested as shown in the figure below or from an alternate power source (such as another vehicle's batteries).

2. Perform the VTM general setup; run confidence test, and enter vehicle ID.

3. a. If power to the VTM comes from a different set of batteries than the battery pack under test, use tests 77 and 79. Connect test probe cable W2 to the battery pack under test. Connect the red clip to the positive terminal closest to the starter. Connect the black clip to the negative terminal closest to vehicle/equipment ground.

   b. If power to the VTM comes from the battery pack under tests, use tests 73 and 75. The test probe cable W2 is not used.

4. Clamp the current probe around the positive cable connected to the starter. Point the arrow on the current probe along the cable leading towards the starter as shown in figure 1.

TEST PROCEDURE

1. Condition the current probe before running these tests.

2. Measure the battery resistance change by entering test number 75 or 79 (as described in the hookup procedure on page D-55). Then engage the starter for about 5 seconds.

3. Measure the battery internal resistance by entering test number 73 or 77 (as described in the hookup procedure on page D-55). Then engage the starter for about 5 seconds.

4. Compare the results of both measurements to limits on the next page.

5. If either measurement is outside of normal limits, check battery terminals and connections, and check battery electrolyte level. Then perform both measurements a second time.

6. If the battery resistance change test (75 or 79) fails after the second measurement, then the battery pack is in bad condition. Test each series pair (see page 75) to determine which is good and which is bad.

7. If the battery internal resistance test (73 or 77) fails after the second measurement, then the battery should be recharged.

FIGURE 1

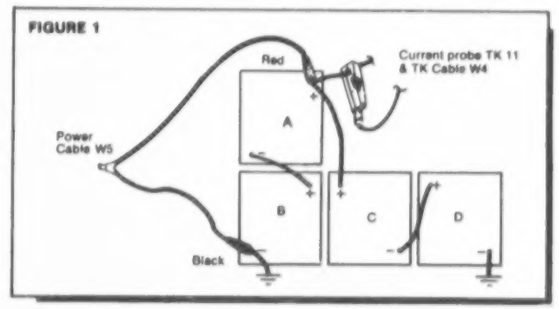


FIGURE 3. SHEET 5 OF 10

STE/ICE BATTERY SERIES PAIR TEST CARD

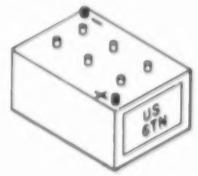
BATTERY TEST RESULTS

STE/ICE DISPLAY AFTER TEST	WHAT IT MEANS
GO	1. The battery in series with the battery under test may be bad. Check that battery next. 2. Check the battery negative cables and cables to the starter for corroded or loose connections. If all of the cables and connections are o.k., then the starter is probably faulty.
.9.9.9.9	1. There is a bad connection on the battery being tested. Clean and tighten the posts and clamps, and check the cable between the batteries. 2. The battery under test is in extremely poor condition.
14.2	If any number is displayed, then the number is a STE/ICE test result. Compare the test result to the values shown along the right edge of this card to determine a pass or fail. See table below to determine the condition of the battery.
E013	1. The battery being tested may be in a discharged state. Check battery electrolyte level; charge battery, and then retest. 2. If display shows E013 after battery has been charged, then the battery is in poor condition.
E002	The current probe is not connected. Connect current probe.
E004	Vehicle ID has not been entered properly. Enter VID.
E005	Offset test for current probe has not been performed. Perform current probe offset test.
E008	Test leads are improperly connected. Check test leads.

TEST LIMITS

BATTERY TEST LIMITS FOR A SERIES PAIR

For Type 6TN Batteries



STE/ICE Test No.	Maximum Acceptable Value to Pass Test
Battery Internal Resistance Test 77	25 Milliohms max.
Battery Resistance Change Test 79	50 Milliohms/Sec max

BATTERY CONDITION

Test 77 Battery internal resistance Test result	Test 79 Battery resistance change Test result	Battery series condition
PASS	PASS	The battery series tested is o.k. and in good state of charge.
PASS	FAIL	The battery series tested is in poor condition, but has a fresh charge.
FAIL	PASS	The battery series tested is o.k., but needs to be recharged.
FAIL	FAIL	The battery series tested is in poor condition and in a state of discharge.

STE/ICE BATTERY SERIES PAIR TEST CARD

The BATTERY INTERNAL RESISTANCE TEST (73 or 77) evaluates the state of charge of the battery series pair. The BATTERY RESISTANCE CHANGE TEST (75 or 79) evaluates whether the battery series is good or bad, even if it is discharged. A good battery series that is discharged may be recharged. A bad battery series may hold a charge for a short time.

STE/ICE HOOKUP

1. The power to operate the STE/ICE VTM may be taken from the batteries being tested as shown in the figure below or from an alternate power source (such as another vehicle's batteries).

2. Perform VTM general setup; run confidence test, and enter vehicle ID.

3. Find a series of batteries. A battery series pair has the negative terminal of one battery connected to the positive terminal of another battery by a cable. For example, in figures 1 and 2 below, batteries A and B are a series pair; and in figure 1 below batteries C and D are a series pair.

4. a. If power to the VTM comes from a different set of batteries under test, use tests 77 and 79 instead of tests 73 and 75. Connect test probe cable W2 to the batteries under test. Connect the red clip to the positive terminal closest to the starter and the black clip lead to the negative terminal closest to the ground.

   b. If power to the VTM comes from the same set of batteries as the batteries under test, use tests 73 and 75. The test probe cable W2 is not used.

5. Clamp the current probe around the cable connecting the two batteries. Point the arrow of the current probe along the cable leading towards the negative battery terminal as shown below in figures 1, 2 and 3 for batteries A and B and batteries C and D.

TEST PROCEDURE

1. Condition the current probe before running these tests.

2. Measure the battery resistance change by entering test number 75 or 79 (as described in the hookup procedure, see page D-55). Then engage the starter for about 5 seconds.

3. Measure the battery internal resistance by entering test number 73 or 77 (as described in the hookup procedure, see page D-55). Then engage the starter for about 5 seconds.

4. Compare the results of both measurements to limits on the next page.

5. If either measurement is outside of normal limits, check battery terminals and connections, and check battery electrolyte level. Then perform both measurements a second time.

6. If the battery resistance change test (75 or 79) fails after the second measurement, then the battery series pair is in bad condition. Test each battery (see page D-77) individually to determine which battery, if any, is good.

7. If the battery internal resistance test (73 or 77) fails after the second measurement, then the batteries should be recharged.

FIGURE 1

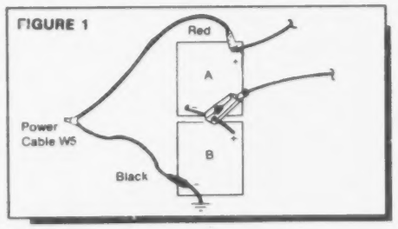


FIGURE 2

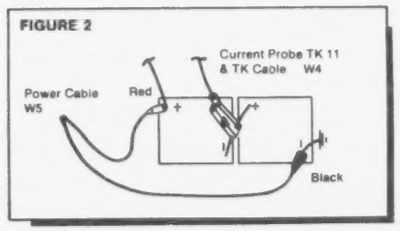


FIGURE 3. SHEET 7 OF 10

STE/ICE INDIVIDUAL BATTERY TEST CARD

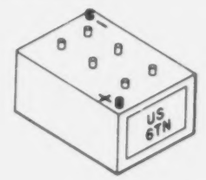
BATTERY TEST RESULTS

STE/ICE DISPLAY AFTER TEST	WHAT IT MEANS
GO	1. The battery in series with the battery under test may be bad. Check that battery next. 2. There is a bad connection in the starter circuit somewhere. Check the battery negative cables, and cables to the starter for corroded or loose connections. If all of the cables and connections are o.k., then the starter is possibly faulty.
.9.9.9.9	1. There is a bad connection on the battery being tested. Clean and tighten the posts and clamps, and check the cable between the batteries. 2. The battery under test is in extremely poor condition.
14.2	If any number is displayed, then the number is a STE/ICE test result. Compare the test result to the values shown along the right edge of this card to determine a pass or fail. See table below to determine the condition of the battery.
E013	1. The battery being tested may be in a discharged state. Check battery electrolyte level; charge battery, and then retest. 2. If display shows E013 after battery has been charged, then the battery is in poor condition.
E002	The current probe is not connected. Connect current probe.
E004	Vehicle ID has not been entered properly. Enter VID.
E005	Offset test for current probe has not been performed. Perform current probe offset test.
E008	Test leads are improperly connected. Check test leads.

TEST LIMITS

INDIVIDUAL BATTERY TEST LIMITS

For Type 6TN Batteries



STE/ICE Test No.	Maximum Acceptable Value to Pass Test
Battery Internal Resistance Test 77	13 Miliohms max.
Battery Resistance Change Test 79	25 Miliohms/Sec max

BATTERY CONDITION

Test 77 Battery internal resistance Test result	Test 79 Battery resistance change Test result	Battery Condition
PASS	PASS	The battery tested is o.k. and in good state of charge.
PASS	FAIL	The battery tested is in poor condition, but has a fresh charge.
FAIL	PASS	The battery tested is o.k., but o.k., but needs to be recharged.
FAIL	FAIL	The battery tested is in poor condition and in a state of discharge.

STE/ICE INDIVIDUAL BATTERY TEST CARD

The BATTERY INTERNAL RESISTANCE TEST (73 or 77) evaluates the state of charge of an individual battery. The BATTERY RESISTANCE CHANGE TEST (75 or 79) evaluates whether the battery is good or bad, even if it is discharged. A good battery that is discharged may be recharged. A bad battery may hold a charge for a short time.

STE/ICE HOOKUP

1. The power to operate the STE/ICE VTM may be taken from the batteries being tested as shown in the figure below or from an alternate power source (such as another vehicle's batteries).

2. Perform VTM general setup; run confidence test and enter vehicle ID.

3. Find the battery series pair that includes the battery under test. A battery series pair is a pair of batteries for which the negative terminal of one battery is connected by a cable to the positive terminal of another battery. For example, in figure 1 and 2 below, batteries A and B are a series pair; and in figure 1 below, batteries C and D are a series pair.

4. If the VTM is powered from an alternate power source, use tests 77 and 79. Connect the red clip of test probe cable W2 to the positive terminal of the battery under test. Connect the black clip of test probe cable W2 to the negative terminal of the battery under test.

5 If the battery under test is part of a series pair of batteries, clamp the current probe around the cable connecting the series pair. Point the arrow on the current probe along the cable leading towards the negative terminal as shown in figures 1 and 2.

TEST PROCEDURE

1. Condition the current probe before running these tests.

2. Measure the battery resistance change by entering test numbe 75 or 79 (as described in the hookup procedure, see page D-55). Then engage the starter for about 5 seconds.

   Measure the battery internal resistance by entering test number 73 or 77 (as described in the hookup procedure, see page D-55). Then engage the starter for about 5 seconds.

   Compare the results of both measurements to limits on the next page.

   If either measurement is outside of normal limits, check battery ter°minals and connections, and check battery electrolyte level. Then perform both measurements a second time.

3. If the battery resistance change test (75 or 79) fails after the second measurment, then the battery is in bad condition. The battery may be able to accept and hold a charge, but it will quickly become discharged during use. A battery in bad condition should be replaced (see page 8-55).

4. If the battery internal resistance (73 or 77) fails after the second measurement, then the battery should be recharged.

FIGURE 1

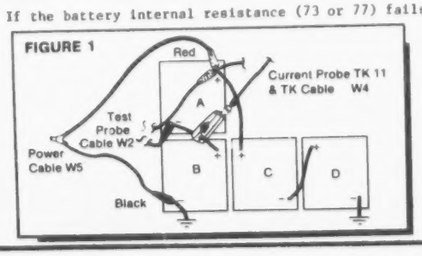


FIGURE 2

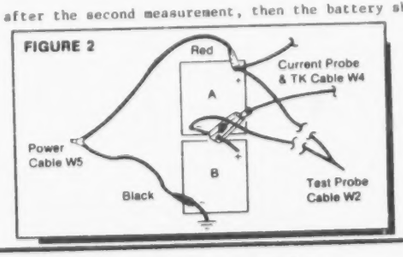


FIGURE 3

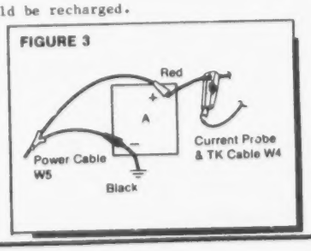


FIGURE 3. SHEET 9 OF 10

STE/ICE BATTERY PACK TEST CARD

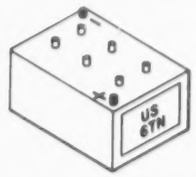
BATTERY TEST RESULTS

STE/ICE DISPLAY AFTER TEST	WHAT IT MEANS
GO	1. The battery in series with the battery under test may be bad. Check that battery next. 2. There is a bad connection in the starter circuit somewhere. Check the battery negative cables, and cables to the starter for corroded or loose connections. If all of the cables and connections are o.k., then the starter is possibly faulty.
.9.9.9.9	1. There is a bad connection on the battery being tested. Clean and tighten the posts and clamps, and check the cable between the batteries. 2. The battery under test is in extremely poor condition.
14.2	If any number is displayed, then the number is a STE/ICE test result. Compare the test result to the values shown along the right edge of this card to determine a pass or fail. See table below to determine the condition of the battery.
E013	1. The battery being tested may be in a discharged state. Check battery electrolyte level; charge battery, and then retest. 2. If display shows E013 after battery has been charged, then the battery is in poor condition.
E002	The current probe is not connected. Connect current probe.
E004	Vehicle ID has not been entered properly. Enter VID.
E005	Offset test for current probe has not been performed. Perform current probe offset test.
E008	Test leads are improperly connected. Check test leads.

TEST LIMITS

BATTERY TEST LIMITS FOR A FOUR BATTERY PACK

For Type 6TN Batteries



STE/ICE Test No.	Maximum Acceptable Value to Pass Test
Battery Internal Resistance Test 77	13 Miliohms max.
Battery Resistance Change Test 79	25 Miliohms/Sec max

BATTERY CONDITION

Test 77 Battery internal resistance Test result	Test 79 Battery resistance change Test result	Battery pack condition
PASS	PASS	The battery pack tested is o.k. and in good state of charge.
PASS	FAIL	The battery pack tested is in poor condition, but has a fresh charge.
FAIL	PASS	The battery pack tested is o.k., but needs to be recharged.
FAIL	FAIL	The battery pack tested is in condition and in a state of discharge.

APPENDIX E
M109A3 ENGINE COMPARTMENT MODIFICATION

Modification effective date as soon as required.

PURPOSE OF MODIFICATION

The purpose of this modification is to modify the M109A3 engine compartment to accept the 8V71T engine P/N 12260210 as a replacement for engines P/N 11665393 and P/N 11652632. This modification is necessary due to the diminishing availability of the latter two engines. Refer to Table E-1 for end item to be modified.

Table E-1. End Item or System to be modified.

Nomenclature	NSN	Part No.	Model No.	Serial No.
Howitzer, Medium, Self-Propelled, 155 mm	2350-01-031-8851	12012200	M109A1/A3	All

MATERIALS

Be sure to inventory modification kit (Table E-2 and Figure E-1), consumable materials (Table E-3) and special tools (Table E-4) before beginning modification procedure.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION

a. Removal

NOTE

- Thoroughly steam clean the vehicle, engine and engine compartment.
- Direct support maintenance must be notified for removal and installation of engine from transfer assembly (removal steps 30 through 35 and installation steps 1 through 8).

1 Drain engine oil, transmission oil and engine coolant systems in accordance with procedures outlined in TM 9-2350-311-10.

2 Remove powerplant in accordance with procedures outlined in Chapter 4. However, the following paragraphs take preference over any conflict with Chapter 4.

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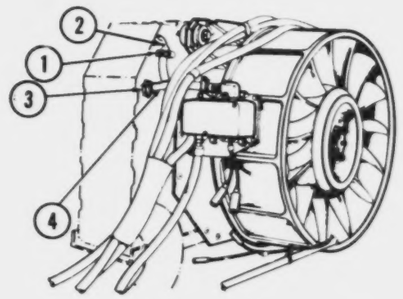
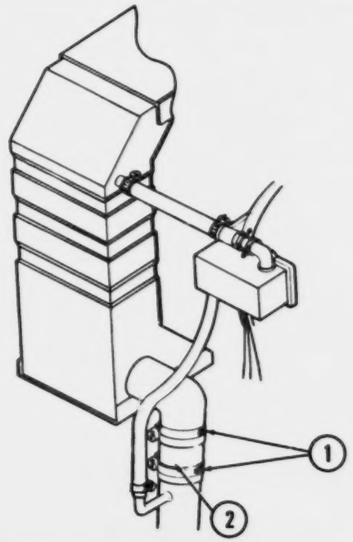


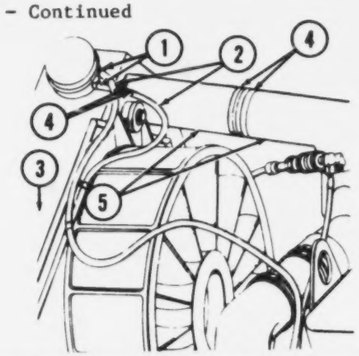
3 Loosen clamp (1) and disconnect surge tank to radiator hose (2). Loosen clamp (3) and disconnect aeration detector to radiator hose (4). Retain all parts for reassembly.



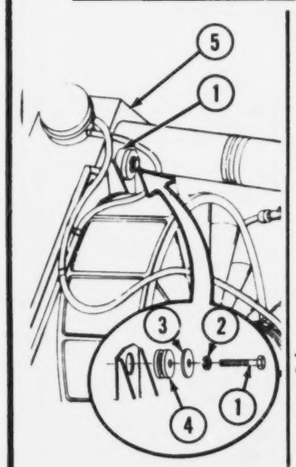
4 Loosen clamps (1) on radiator outlet to coolant tube hose (2). Retain parts for reassembly.

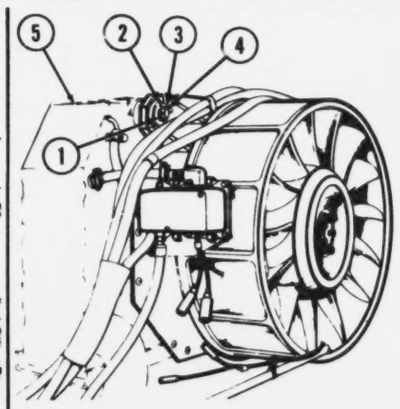
APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

a. Removal - Continued

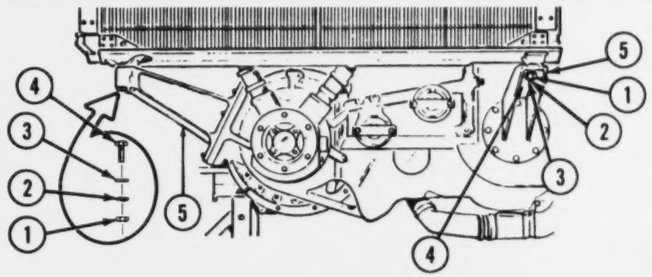


5 Loosen two vent hose clamps (1) and remove two vent hoses (2) from radiator (3). Loosen four inlet hose clamps (4) and remove radiator inlet hose (5) from radiator (3). Retain all parts for reassembly.

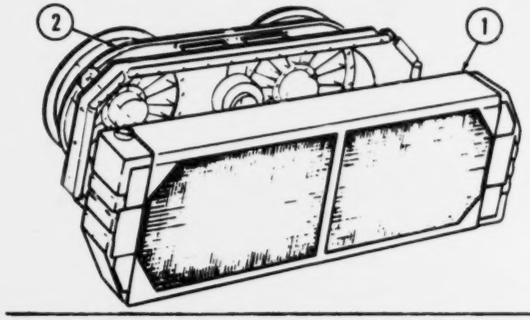




6 Remove two bolts (1), two lockwashers (2), two flatwashers (3) and two resilient mounts (4) from radiator (5). Retain all parts for reassembly.



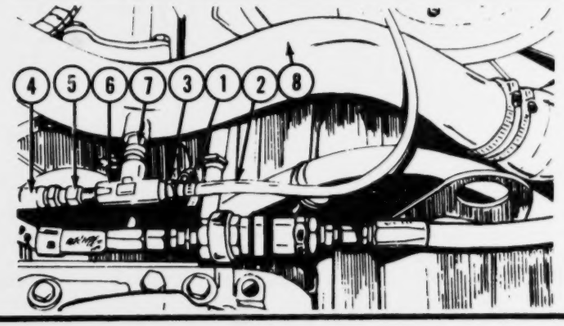
7 Remove two nuts (1), two lockwashers (2), two flatwashers (3) and two screws (4) from radiator mounting brackets (5). Retain all parts for reassembly.



NOTE

Removing radiator will require at least two men.

8 Carefully lift radiator (1) up and away from radiator shroud (2).

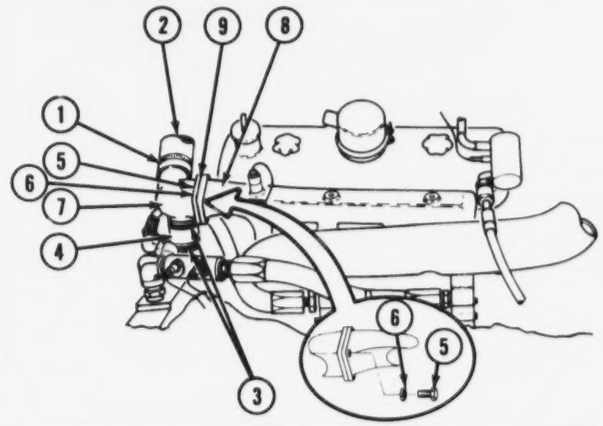


9 Remove the alternator in accordance with procedures outlined on page 8-3.

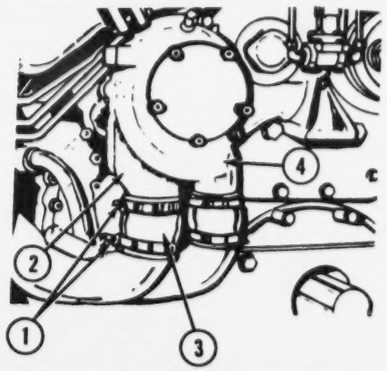
10 Loosen clamp (1). Remove crossover tube to radiator vent hose (2), adapter (3), crossover tube to surge tank hose (4), nipple (5) and tee (6). Retain all parts for reassembly. Remove nipple (7) from crossover tube (8). Discard nipple (7).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

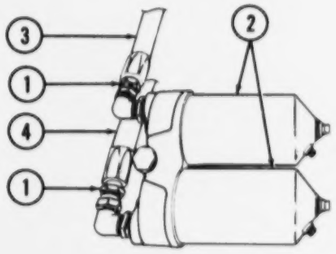
a. Removal - Continued



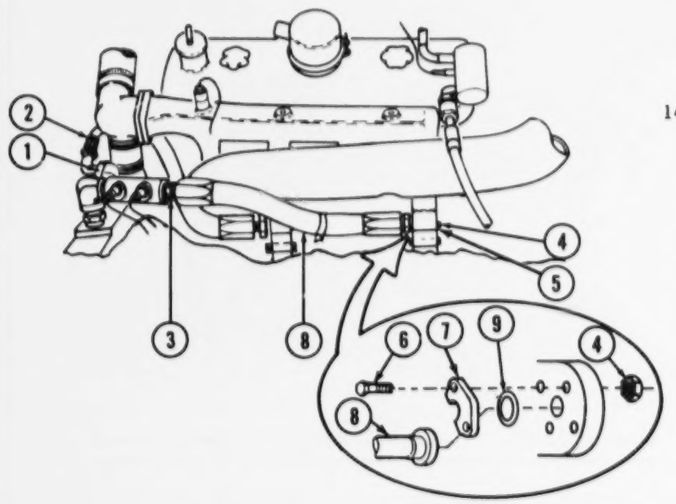
11 Loosen clamp (1) on crossover tube (2) and disconnect crossover tube (2). Loosen two clamps (3) on thermostat housing hose (4). Remove four cap screws (5) and lockwashers (6) from manifold connector housing (7). Remove manifold connector housing (7) from coolant manifold (8) and thermostat housing hose (4). Remove and discard gasket (9). Retain all other parts for reassembly. Repeat procedure on right side of engine.



12 Loosen two clamps (1) at coolant pump inlet tube (2) and remove connector hose (3) from coolant pump (4). Discard hose (3). Retain all other parts for reassembly.



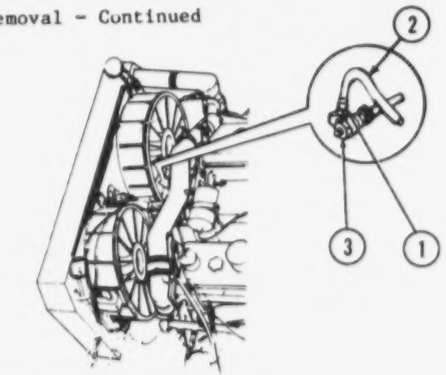
13 Loosen two hose connector nuts (1) at engine oil filters (2) and disconnect engine oil filter to oil cooler hose (3) and oil cooler to filter hose (4).



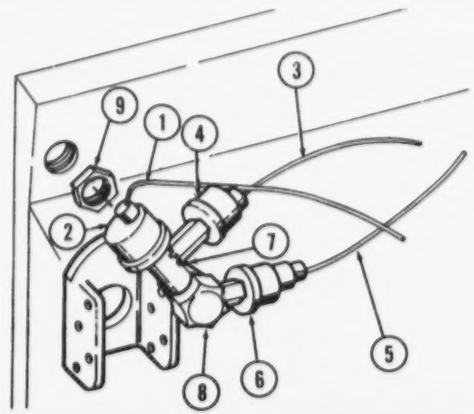
14 Loosen nut (1) and disconnect oil cooler to transmission hose (2). Loosen transmission to oil cooler hose connector (3). Remove four nuts (4) and four lockwashers (5) from rear of oil cooler. Remove four screws (6) and two split flanges (7) from transmission to oil cooler hose (8). Remove hose (7) and preformed packing (9). Discard preformed packing (9). Retain all other parts for reassembly.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

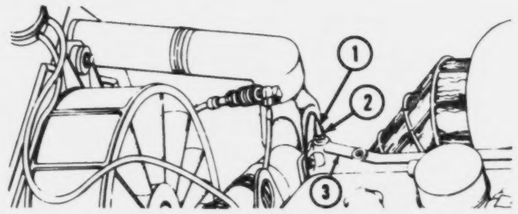
a. Removal - Continued



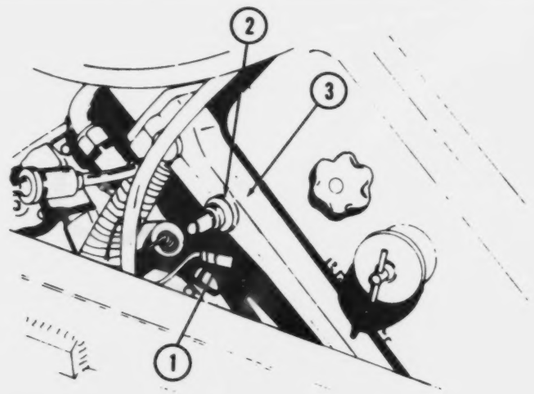
15 Remove nut (1) and tachometer cable (2) at drive joint (3). Retain all parts for reassembly.



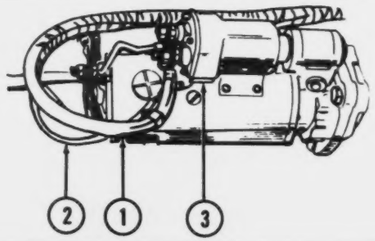
16 Disconnect electrical leads 415B (1) from air cleaner blower motor switch (2), 509B (3) from engine oil low pressure switch (4) and 36 (5) from engine oil pressure transmitter (6). Unscrew and remove pressure switches (2 and 4) and pressure transmitter (6) from body (8). Unscrew tee (7) from body (8). Loosen and remove body (8) and seal (9). Discard seal (9). Retain all other parts for reassembly.



17 Disconnect electrical lead 33A (1) from engine coolant temperature transmitter (2). Unscrew and remove transmitter (2) from coolant manifold (3). Retain transmitter (2) for reassembly.



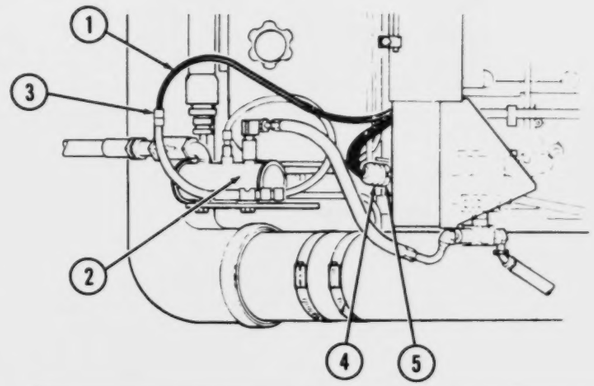
18 Disconnect electrical lead 509A (1) from engine coolant high temperature switch (2) from coolant manifold (3). Retain switch (2) from coolant manifold (3). Retain switch (2) for reassembly.



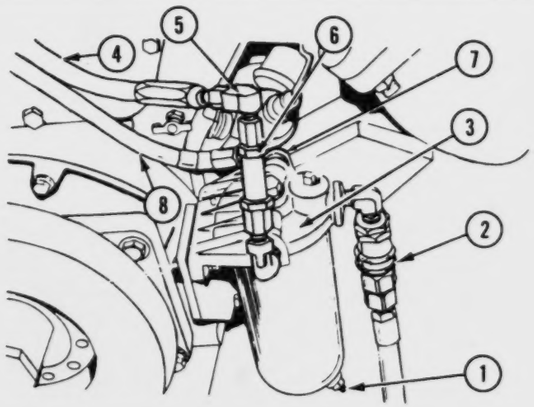
19 Disconnect starter cable (1) and solenoid lead (2) from starter solenoid (3). Retain hardware for reassembly.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

a. Removal - Continued



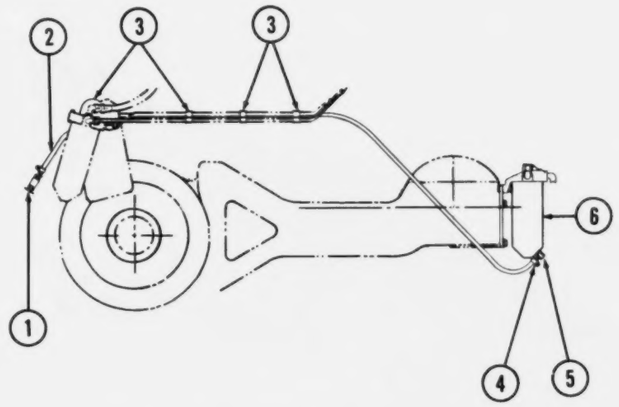
20 Disconnect electrical lead 588 (1) from electric fuel pump (2) at connector (3). Disconnect flame heater system connector (4) from engine disconnect bracket (5).



NOTE

The drain cock on some primary fuel filters is located either at the bottom of the filter housing, or at the end of a drain hose assembly. Make certain that the fuel filter is drained before removing.

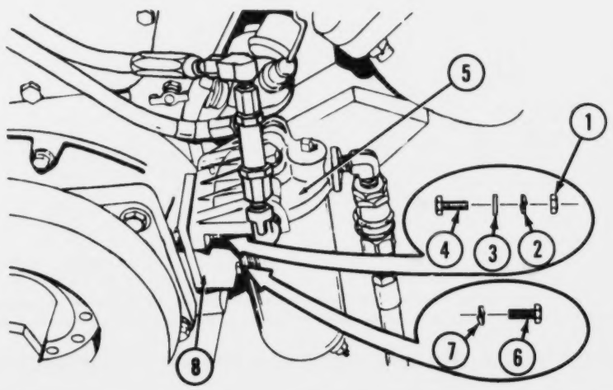
21 Open drain cock (1) on primary fuel filter (3) and drain filter. Remove coupler half (2) from fuel filter (3). Remove hose (4), elbow (5) and adapter (6). Remove elbow (7) and hose (8). Retain all parts for reassembly.



NOTE

If the drain cock is located at the end of a drain hose assembly, follow step (22) to remove the drain hose assembly and additional hardware.

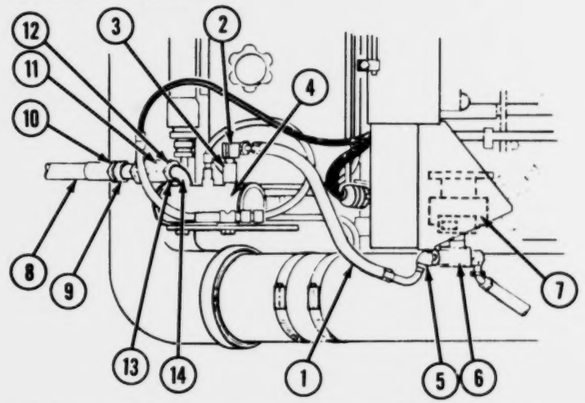
22 Open drain cock (1) on drain hose assembly (2) and drain filter. Remove four clamps (3). Replace screws and washers. Loosen clamp (4) and disconnect drain hose assembly (2) from elbow (5). Remove elbow (5) from fuel filter (6). Retain all parts for reassembly.



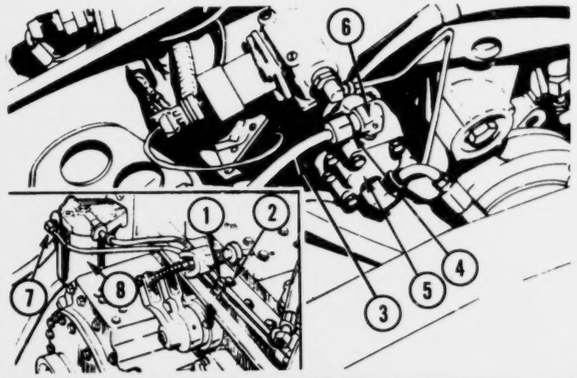
23 Remove two nuts (1), two lockwashers (2), two flatwashers (3), two screws (4) and fuel filter (5). Remove two screws (6) and two lockwashers (7) from filter bracket (8). Remove filter bracket (8). Retain all parts for reassembly.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

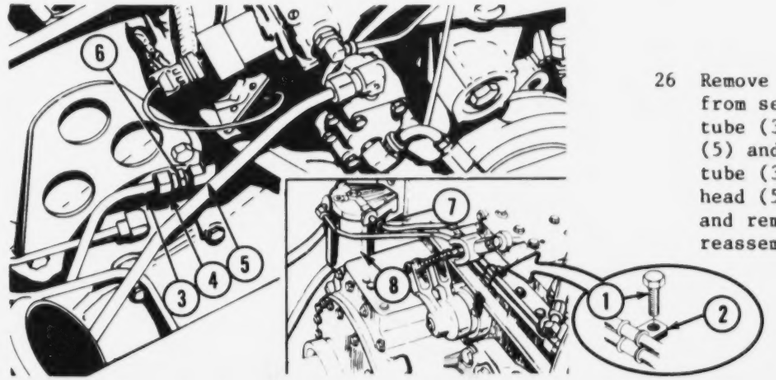
a. Removal - Continued



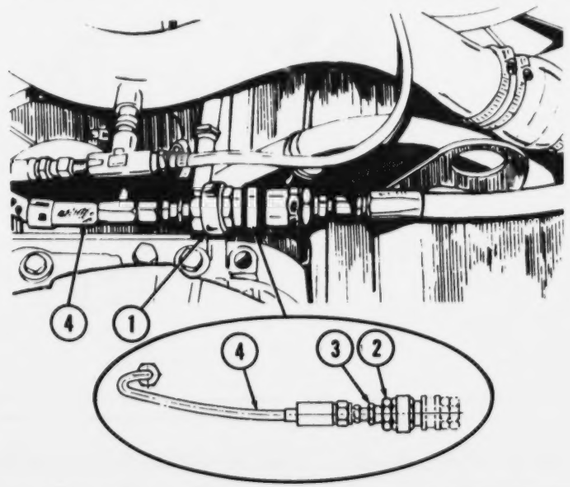
24 Disconnect hose (1) at elbow (2) and elbow (5) and remove hose (1). Remove elbow (2) and coupling (3) from electrically driven fuel pump (4). Remove elbow (5). Remove tee and elbow assembly (6) from engine driven fuel pump (7). Disconnect hose (8) from nipple (9). Remove preformed packing (10), nipple (9), check valve (11), preformed packing (12), adapter (13) and elbow (14) from electrically driven fuel pump (4). Discard preformed packings (10 and 12). Retain all other parts for reassembly.



25 Remove three screws (1) and three clamps (2) from secondary fuel filter to fuel pump tube (3). Loosen nut (4) at fuel pump (5) and disconnect filter to pump tube (3). Remove elbow (6) from fuel pump (5). Loosen nut (7) at fuel filter (8) and remove tube (3). Retain all parts for reassembly.



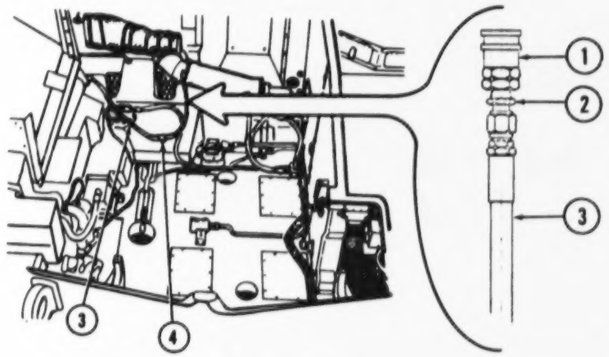
26 Remove three screws (1) and three clamps (2) from secondary fuel filter to cylinder head tube (3). Loosen nut (4) at cylinder head (5) and disconnect filter to cylinder head tube (3). Remove adapter (6) from cylinder head (5). Loosen nut (7) at fuel filter (8) and remove tube (3). Retain all parts for reassembly.



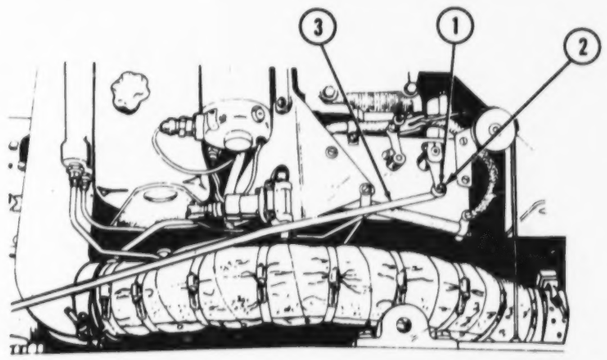
27 Remove clamp (1), coupler half (2) and bushing (3) from engine fuel return hose (4). Discard return hose (4). Return all other parts for reassembly.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

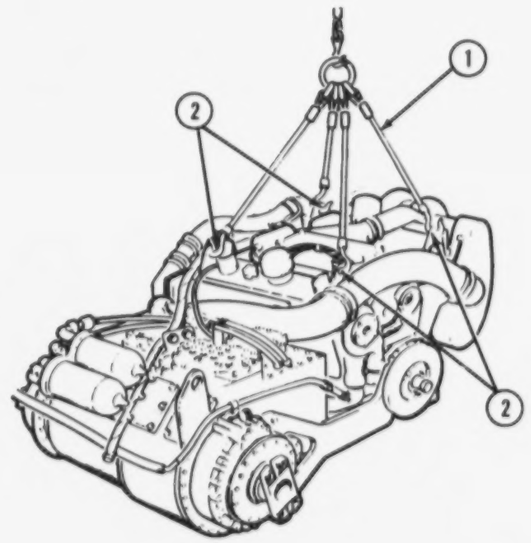
a. Removal - Continued



28 Remove coupler half (1) and nipple (2) from fuel tank return hose (3). Remove clamp (4) and hose (3). Discard clamp (4) and hose (3). Retain all other parts for reassembly.



29 Remove pin (1) and two washers (2) and engine throttle governor control rod (3). Retain all parts for reassembly.



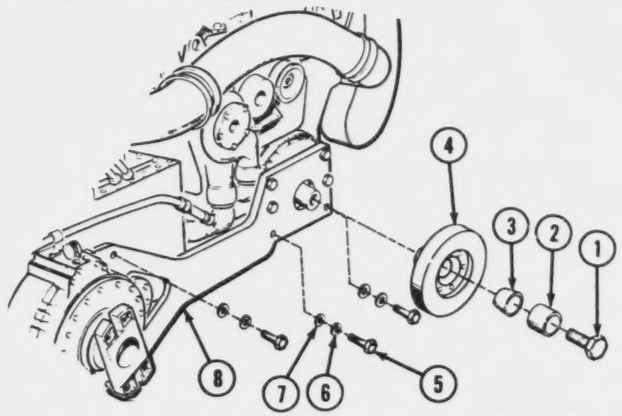
30 Attach sling and hoist (1) at four lifting eyes (2). Slowly raise hoist just enough to remove the slack in the sling lines.

CAUTION

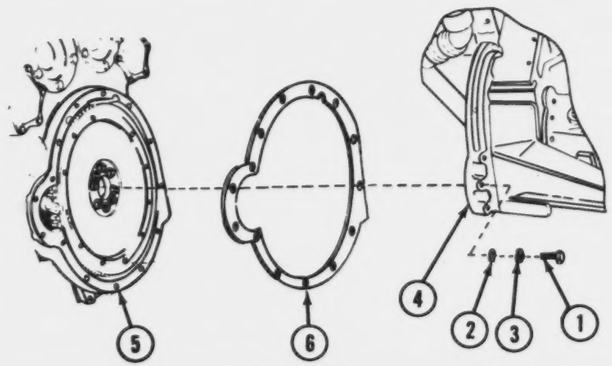
Check transmission support at transfer assembly and make certain the transmission is supported to prevent the transmission from rolling when the engine is removed.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

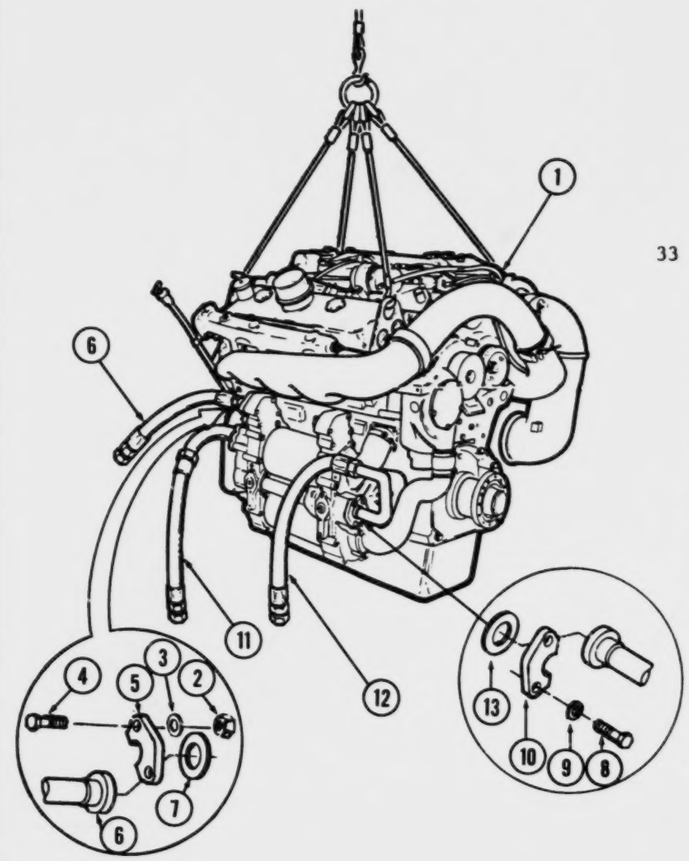
a. Removal - Continued



31 Loosen bolt (1) on vibration damper and hub assembly (4) approximately 1/8 inch. Use a hammer and strike a sharp blow on the head of bolt (1) to loosen split cone (3). Remove bolt (1), spacer (2), split cone (3) and vibration damper and hub assembly (4). Discard split cone. Remove 12 bolts (5), 12 lockwashers (6) and 12 flatwashers (7) while supporting tie bar (8) and remove tie bar (8). Reinstall vibration damper and hub assembly (4), new split cone (3), spacer (2) and bolt (1) on engine. Retain all parts for reassembly.



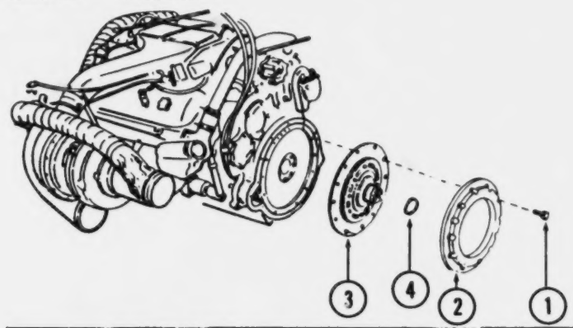
32 Remove 14 screws (1), 14 flatwashers (2) and 14 lockwashers (3) from transfer assembly (4) and engine assembly (5). Remove and discard gasket (6). Retain all other parts for reassembly.



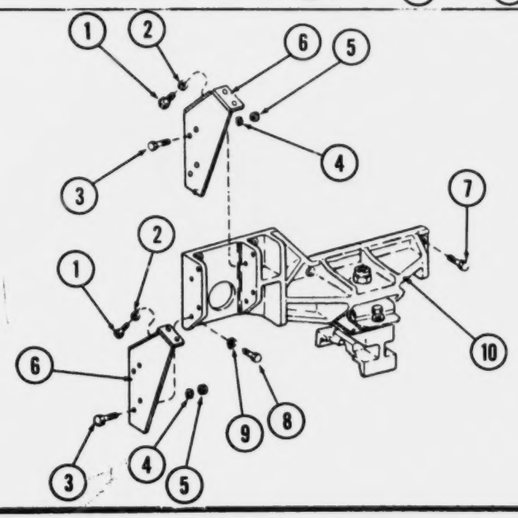
33 Pull engine (1) away from transfer assembly and slowly raise engine with the hoists. Carefully place the engine on an engine stand. Remove four nuts (2), four lockwashers (3), four bolts, (4) and two split flanges (5) from oil cooler to transmission hose (6). Remove hose (6) and preformed packing (7). Remove eight bolts (8), eight lockwashers (9) and four split flanges (10) from engine oil filter-to-oil cooler hose (11) and oil cooler-to-filter hose (12). Remove hoses (11 and 12) and two preformed packings (13). Discard preformed packings (7 and 13). Retain all other parts for reassembly.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

a. Removal - Continued

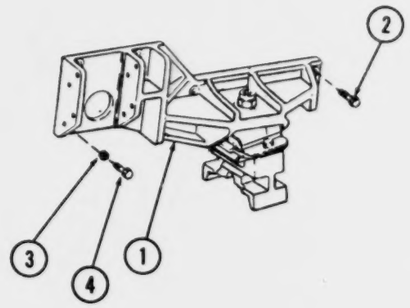


34 Remove 12 screws (1) from mass ring (2) and coupler (3). Remove mass ring (2) and coupler (3) from engine flywheel. Remove and discard seal (4) from coupler (3). Retain all other parts for reassembly.



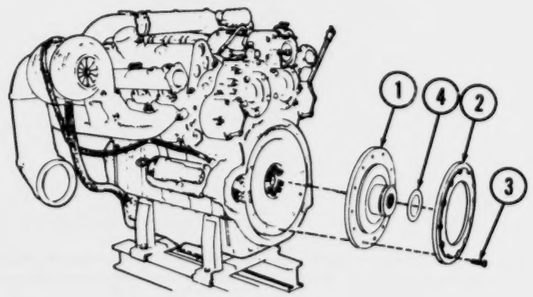
35 Remove four screws (1), four washers (2), eight screws (3), eight washers (4) and eight nuts (5) from two supports (6). Remove two supports (6) from engine shock mount and bracket assembly (10). Discard all parts. Remove eight screws (7), three screws (8) and three washers (9) from engine shock mount and bracket assembly (10). Retain these parts for reassembly.

b. Installation



1 Install powerplant in accordance with procedures outlined in Chapter 4. However, the following paragraphs take preference over any conflict with Chapter 4.

2 Install engine shock mount and bracket assembly (1) on engine. Secure with eight screws (2), three washers (3) and three screws (4). Tighten eight screws (2) to 60-65 lb-ft torque. Tighten three screws (4) to 35 lb-ft torque.



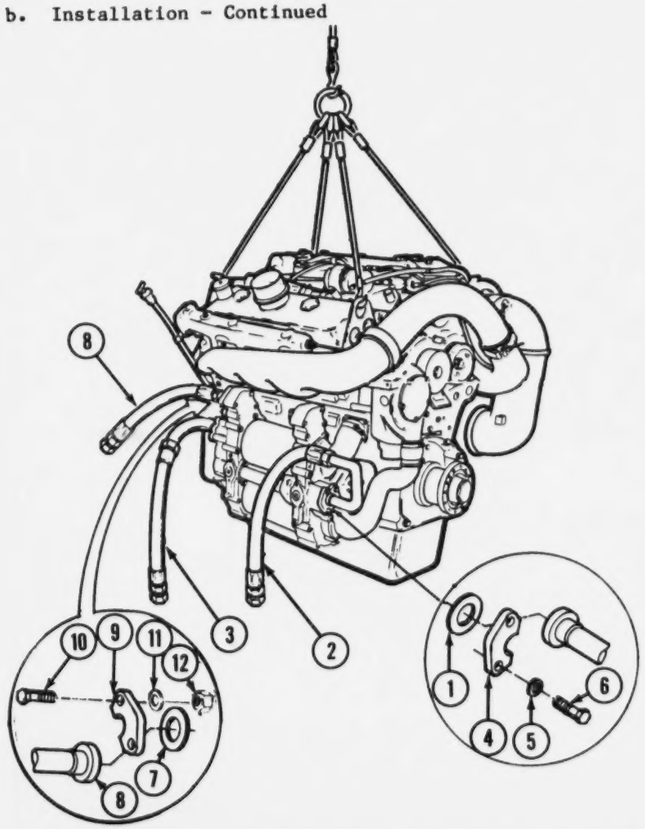
NOTE

Coat coupling seal grooves, splined teeth and seals with Silicone Lubricant.

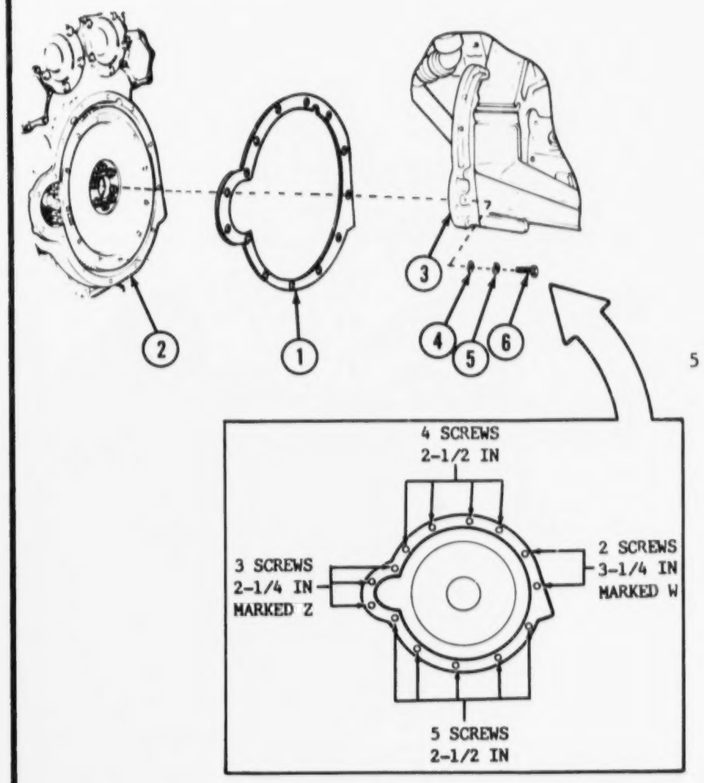
3 Install coupler (1) and mass ring (2) on engine flywheel. Secure with 12 screws (3). Tighten 12 screws (3) to 40-50 lb-ft torque. Install new preformed packing (4) on coupler (1).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

b. Installation - Continued



4 Install one each new preformed packing (1) in oil cooler to filter hose (2) and engine oil filter to oil cooler hose (3). Install hoses (2 and 3) on engine. Secure with four split flanges (4), eight lockwashers (5) and eight bolts (6). Install new preformed packing (7) in oil cooler to transmission hose (8). Install hose (8) on engine. Secure with two split flanges (9), four bolts (10), four lockwashers (11) and four nuts (12).



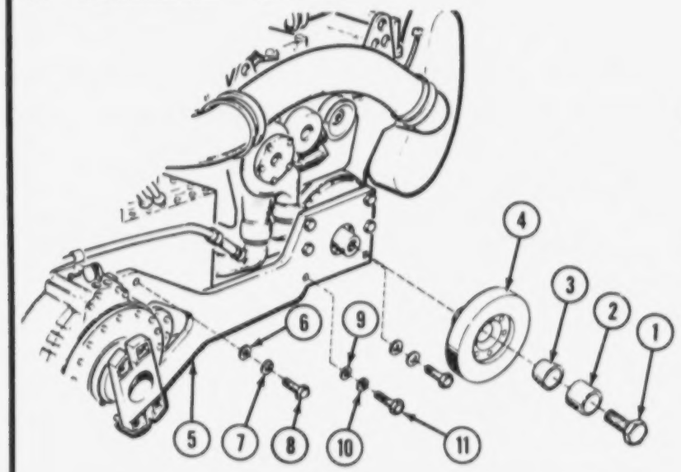
NOTE

Lubricant MIL-G-10924 may be applied to new gasket (1) or mating surfaces for retention during assembly.

5 Install new gasket (1) on engine (2). Slowly lower hoist to aline flywheel hub with transfer case output shaft. Carefully push engine (2) forward against transfer case (3). Secure as illustrated with 14 flatwashers (4), 14 lockwashers (5) and 14 screws (6).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

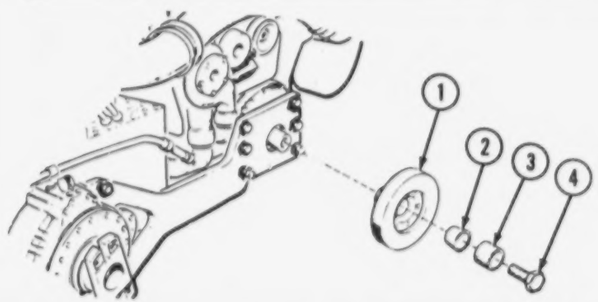
b. Installation - Continued



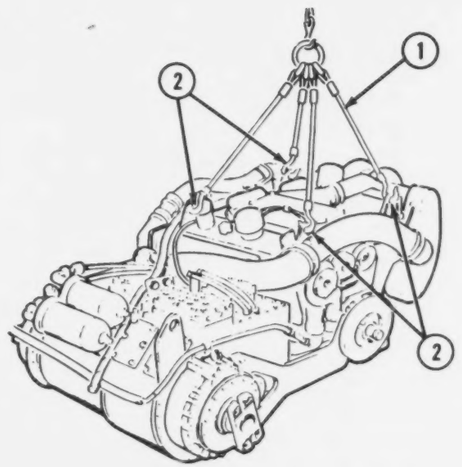
NOTE

Extreme care must be taken to insure proper alinement of the engine and transmission to tie bar (5).

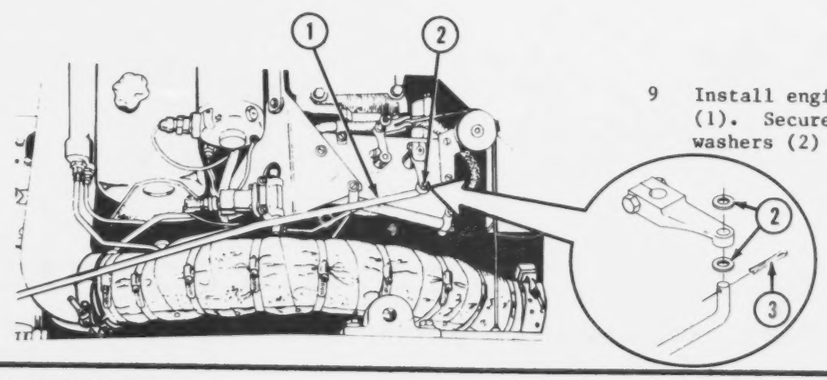
6 Loosen bolt (1) on vibration damper and hub assembly (4) approximately 1/2 in. Use a hammer and strike a sharp blow on the head of bolt (1) to loosen split cone (3). Remove bolt (1), spacer (2), split cone (3) and vibration damper and hub assembly (4). Install tie bar (5) on engine and transmission. Hold in position on engine end with flatwasher (6), lockwasher (7) and bolt (8). Install remaining hardware; ten flatwashers (9), ten lockwashers (10) and ten bolts (11). Tighten bolts (10) on engine end of tie bar (5) to 75-90 lb-ft. Torque bolts (10) on transmission end of tie bar (5) to 90-110 lb-ft torque.



7 Install vibration damper and hub assembly (1), new split cone (2) and spacer (3) on engine. Secure with bolt (4). Tighten bolt (4) to 180 lb-ft torque. Strike head of bolt (4) with a two to three pound hammer and retighten bolt (4) to 300 lb-ft torque. Strike head of bolt (4) with a hammer again and retighten to 300-330 lb-ft torque.



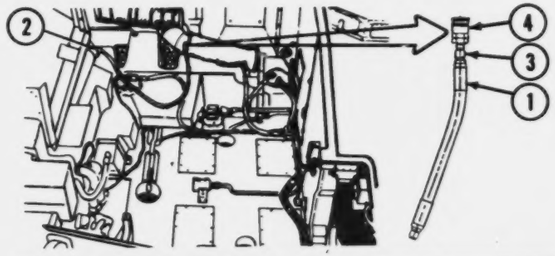
8 Slowly lower hoist to release tension on sling lines (1). Remove sling lines (1) from four engine lifting eyes (2).



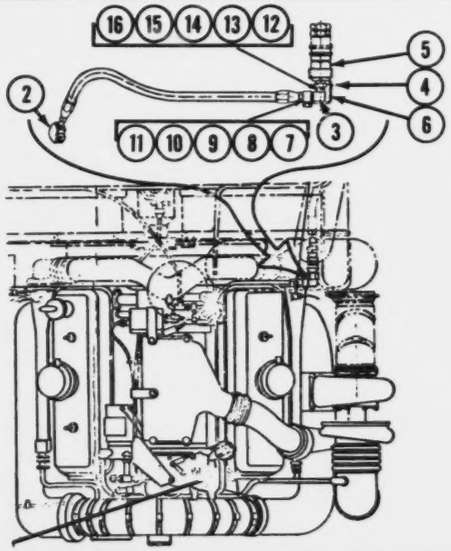
9 Install engine throttle governor control rod (1). Secure control rod (1) with two washers (2) and pin (3).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

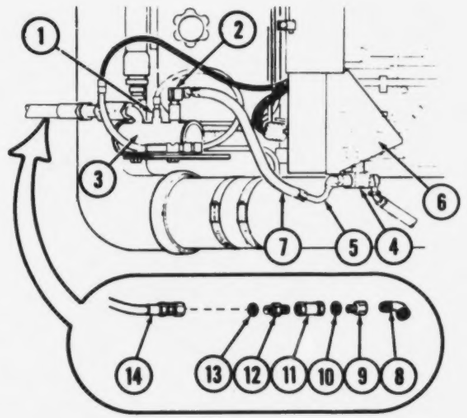
b. Installation - Continued



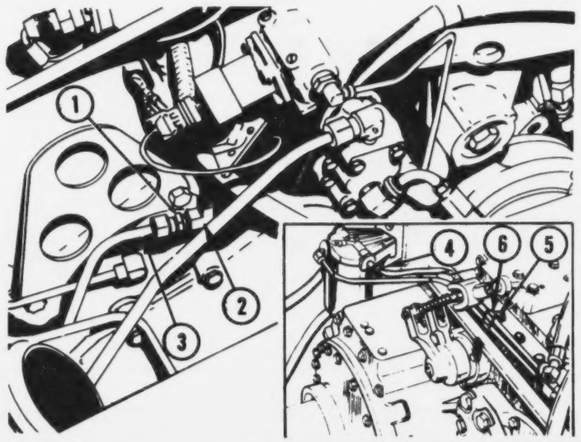
10 Install new hose assembly (1) to lower fuel tank fuel return part (2). Install nipple (3) and nipple half (manel) of coupler (4) to end of hose assembly (1). Tie hose assembly (1) in an accessible position so coupler (4) can be reached when powerplant is installed.



11 Install new fuel return hose (1) on tee (2). Tee (2) is furnished with the new engine. Install new elbow (3) on return hose (1). Install bushing (4) and coupler half (5) on elbow (3). Install new bracket (6) using existing hardware. Install new clamp (7), screw (8), flatwasher (9) and lockwasher (10) and nut (11). Install clamp (12), new screw (13), flatwasher (14), lockwasher (15) and nut (16).



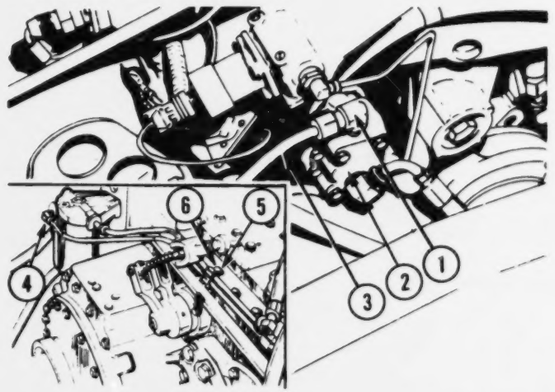
12 Install coupling (1) and elbow (2) on electrically driven fuel pump (3). Install tee and elbow assembly (4) and elbow (5) on engine driven fuel pump (6). Install hose (7) on elbow (2) and elbow (5). Install elbow (8), adapter (9), new preformed packing (10), check valve (11), nipple (12) and new preformed packing (13) on electrically driven fuel pump (3). Connect hose (14) on nipple (12).



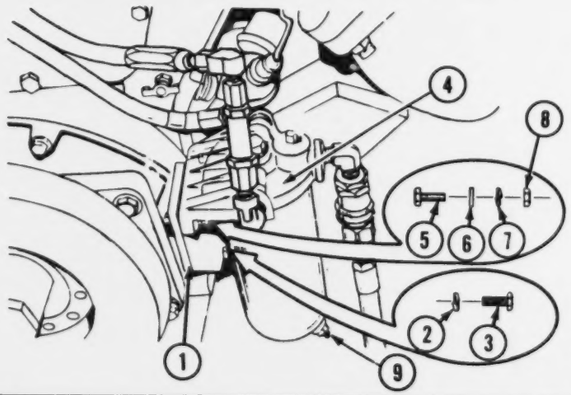
13 Install adapter (1) in cylinder head (2). Connect cylinder head tube (3) at adapter (1) and secondary fuel filter elbow (4). Secure cylinder head tube (3) with three clamps (5) and three screws (6).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

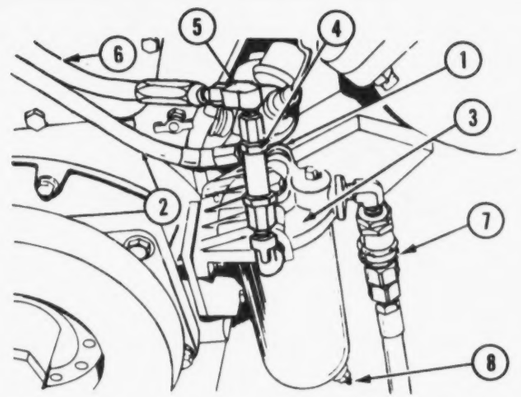
b. Installation - Continued



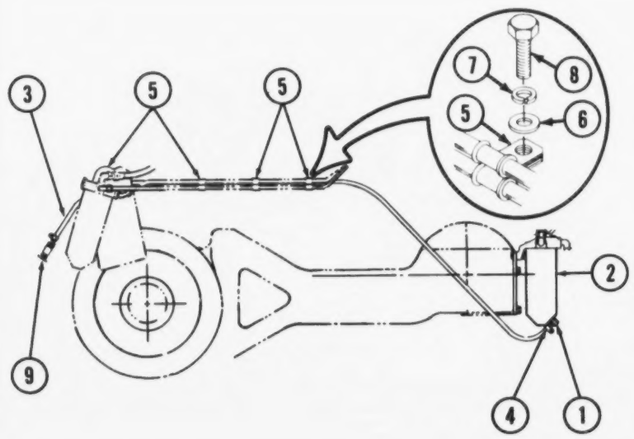
14 Install elbow (1) in fuel pump (2). Connect secondary fuel filter to fuel pump tube (3) at elbow (1) and secondary fuel filter elbow (4). Secure fuel filter to fuel pump tube (3) with three clamps (5) and three screws (6).



15 Install fuel filter bracket (1) on engine block. Secure bracket (1) with two lockwashers (2) and two screws (3). Install fuel filter (4) on bracket (1) and secure with two screws (5) , two lockwashers (6), two flatwashers (7) and two nuts (8). Make sure drain cock (9) is closed.



16 Install elbow (1) and hose (2) on fuel filter (3). Install adapter (4), elbow (5) and hose (6) on fuel filter (3). Install coupler (7) on fuel filter (3). Make certain drain cock (8) is closed.



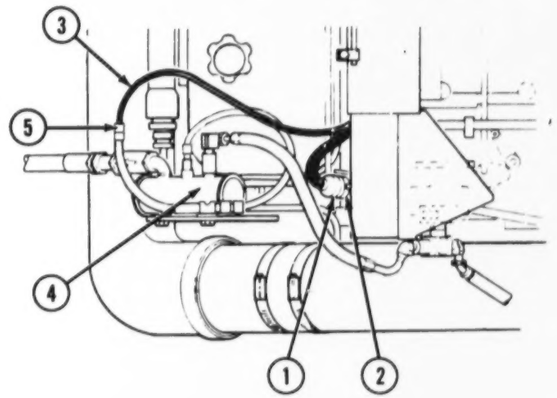
NOTE

If drain cock is located at the end of a drain hose assembly, follow step (17) to install drain hose assembly and attaching hardware.

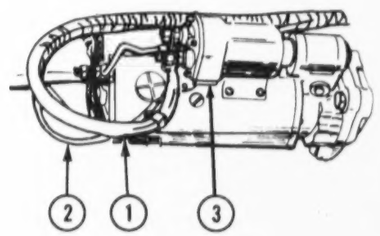
17 Install elbow (1) on fuel filter (2). Install drain hose assembly (3) on elbow (1). Tighten clamp (4). Secure drain hose assembly (3) with four clamps (5), four flatwashers (6), four lockwashers (7) and four screws (8). Make certain drain cock (9) is closed.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

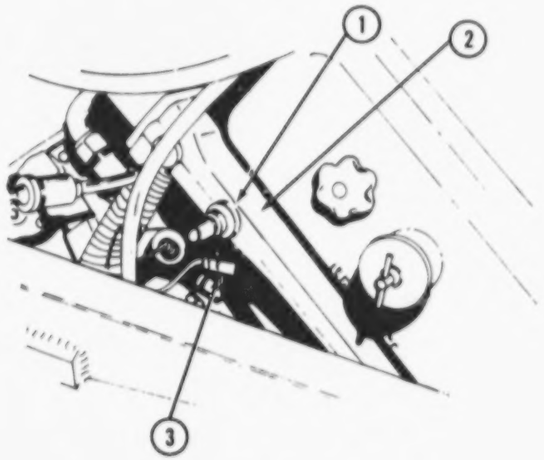
b. Installation - Continued



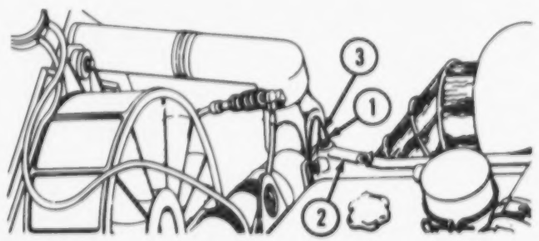
18 Connect flame heater system connector (1) in engine disconnect bracket (2). Connect electrical lead 588 (3) to electric fuel pump (4) at connector (5).



19 Install starter cable (1) and solenoid lead (2) on starter solenoid (3). Secure with existing hardware.



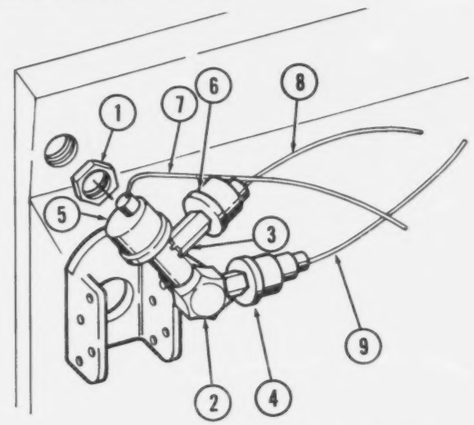
20 Install engine coolant high temperature switch (1) in coolant manifold (2). Connect electrical lead 509A (3) on temperature switch (1).



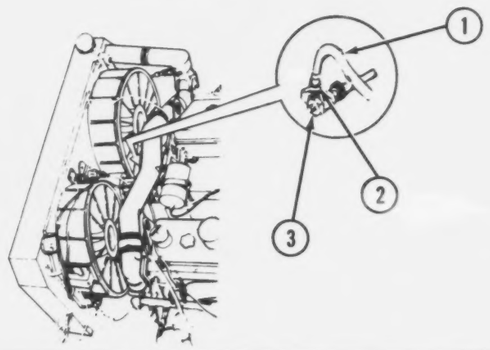
21 Install engine coolant transmitter (1) in coolant manifold (2). Connect electrical lead 33A (3) on transmitter (1).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

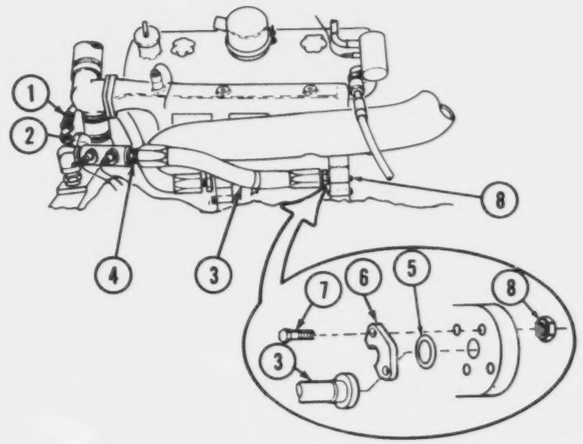
b. Installation - Continued



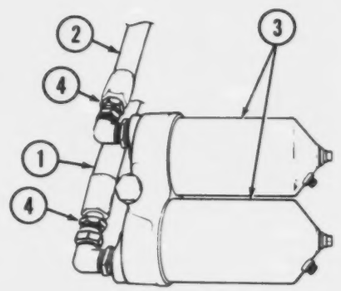
22 Install new seal (1) and body (2). Install tee (3) on body (2). Install pressure switches (4 and 5) and pressure transmitter (6) on body (2). Connect electrical leads 415B (7) on air cleaner blower motor (5), 509B (8) on engine oil low pressure switch (6) and 36 (9) on engine oil pressure transmitter (4).



23 Install tachometer cable (1) on drive joint (3). Secure cable (1) with nut (2).



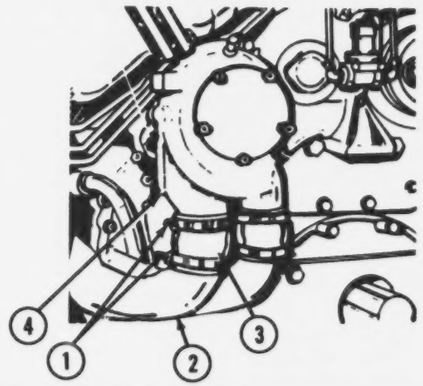
24 Install oil cooler to transmission hose (1) at transmission (2). Connect transmission to oil cooler hose (3) at connector (4). Install new preformed packing (5) in transmission to oil cooler hose (3). Connect hose (3) at oil cooler using two split flanges (6), four screws (7) and four nuts (8).



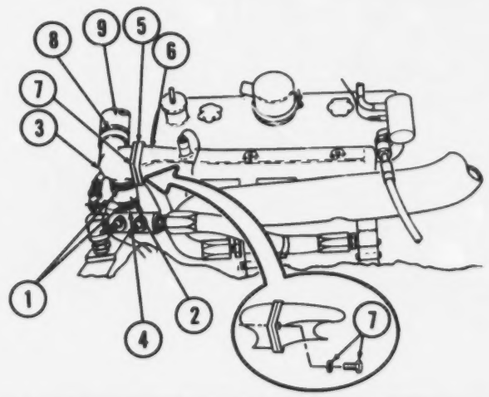
25 Connect engine oil filter to oil cooler hose (1) and oil cooler to filter hose (2) at oil filters (3). Tighten two hose connector nuts (4).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

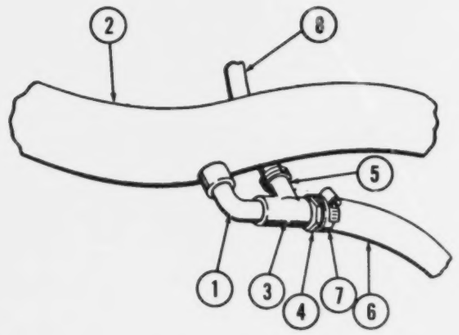
b. Installation - Continued



26 Slide two clamps (1) on main coolant tube (2). Install new connector hose (3) on main coolant tube (2) and coolant pump inlet (4). Position two clamps (1) on new connector hose (3) and tighten clamps.

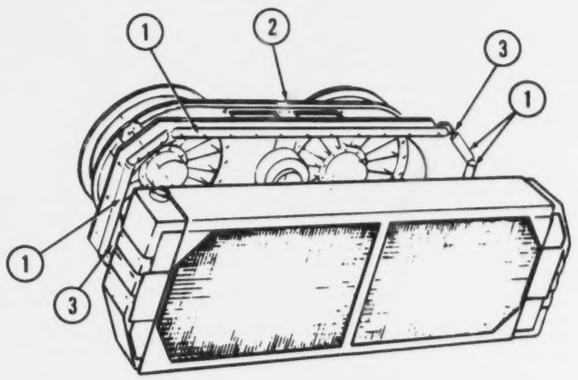


27 Position two clamps (1) on thermostat housing hose (2). Install one end of hose (2) on manifold connector housing (3). Install opposite end of hose (2) with connector housing (3) on thermostat housing (4). Install new gasket (5) between connector housing (3) and coolant manifold (6). Aline and install connector housing (3) on coolant manifold (6) with four cap screws and lockwashers (7). Tighten two clamps (1). Position clamp (8) on crossover tube (9). Install crossover tube (9) on connector housing (3) and tighten clamp (8). Repeat procedure on right side of engine.



28 Install new elbow (1) on crossover tube (2). Install tee (3) and adapter (4) on elbow (1). Install nipple (5) on tee (3). Connect radiator vent hose (6) to crossover tube adapter (4) and secure with clamp (7). Connect surge tank hose (8) to crossover tube nipple (5).

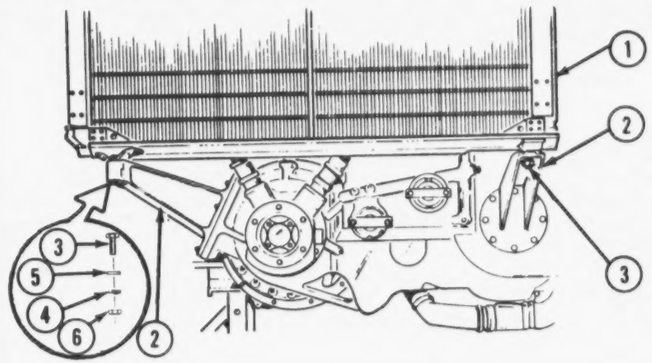
29 Install the alternator in accordance with procedures outlined on page 8-3.



30 Tape seal (1) on cooling fan shroud (2) at oil eight joints (3) with 3/4 in. insulating tape.

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

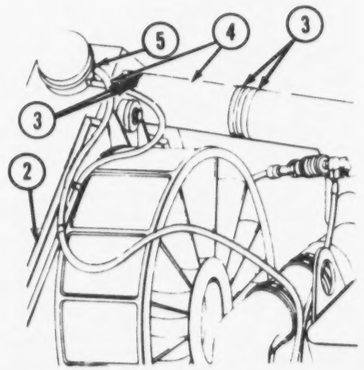
b. Installation - Continued



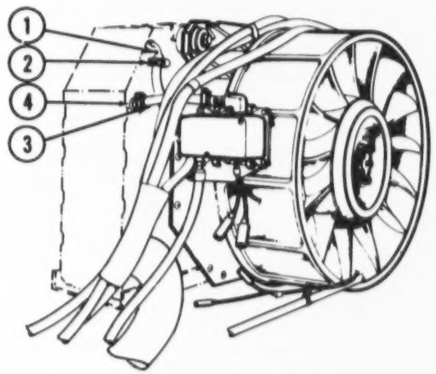
NOTE

Installing a radiator will require at least two men.

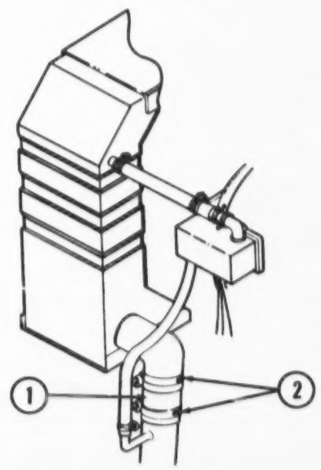
31 Carefully lower radiator (1) and move against shroud. Aline radiator (1) on mounting brackets (2) and secure with two screws (3), two lockwashers (4), two flatwashers (5) and two nuts (6).



32 Connect radiator inlet hose (1) to radiator (2). Secure inlet hose (1) with 4 clamps (3). Install two vent hoses (4) on radiator cap and secure with two clamps (5).



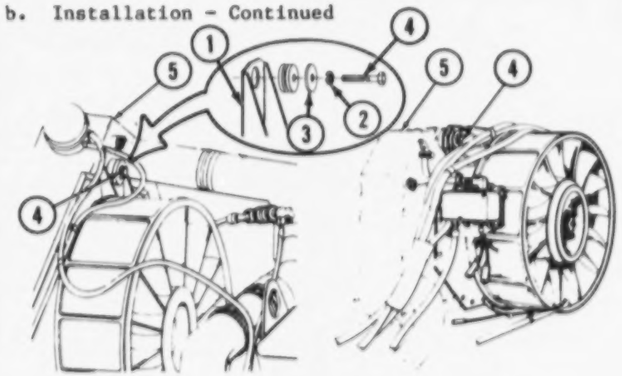
33 Connect surge tank to radiator hose (1) at radiator and secure with clamps (2). Connect aeration detector to radiator hose (3) and secure with clamp (4).



34 Make certain that radiator outlet to coolant tube hose (1) is properly installed and tighten two clamps (2).

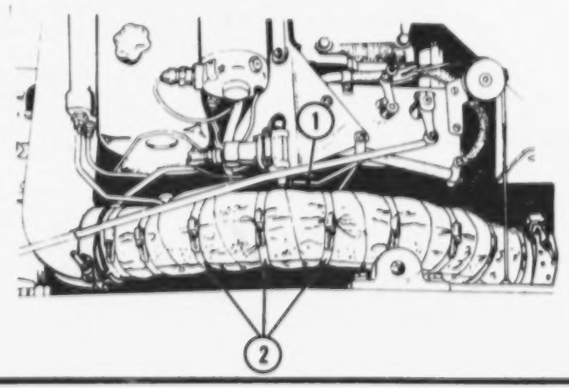
APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

b. Installation - Continued

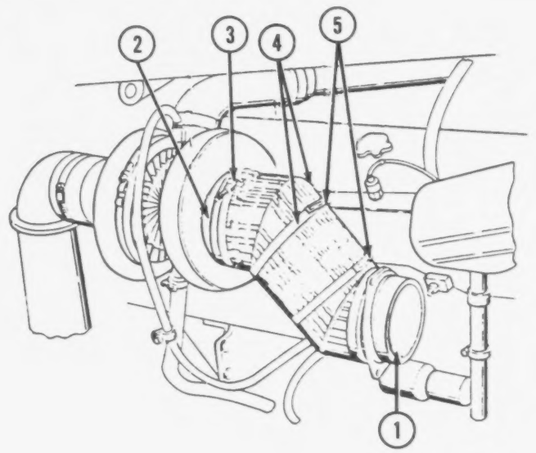


RADIATOR REAR RADIATOR FRONT

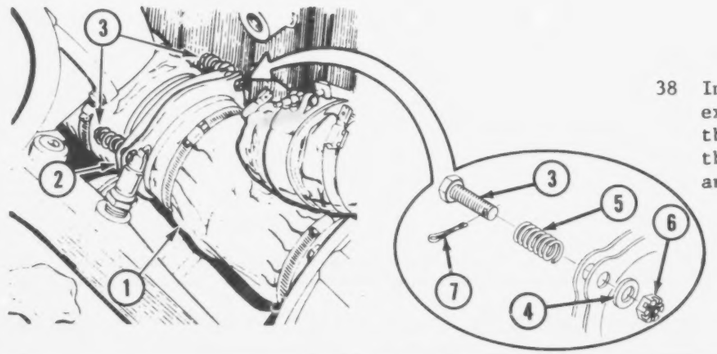
35 Install two resilient mounts (1), two lockwashers (2), two flatwashers (3) and two bolts (4) on radiator (5). Tighten bolts (4) to 35-45 lb-ft torque.



36 Wrap engine exhaust crossover pipe with new thermal insulation blanket (1). Secure insulation blanket (1) with nine new clamps (2) equally spaced on the crossover pipe.



37 Install new turbo exhaust pipe (1) on turbocharger outlet (2). Position new V-band coupling (3) loosely around exhaust pipe (1). Install new front and rear exhaust pipe insulation (4) around exhaust pipe (1). Secure insulation (4) with 2 new clamps (5) equally spaced on exhaust pipe (1). Make certain that exhaust pipe (1) and insulation (4) is properly installed at outlet (2).



38 Install turbo exhaust pipe (1) on engine exhaust duet flange (2) and secure with three new screws (3), three new washers (4), three new springs (5), three new nuts (6) and three new cotter pins (7).

APPENDIX E. M109A3 ENGINE COMPARTMENT MODIFICATION - CONTINUED

b. Installation - Continued

39 Install drain covers and drain plugs in accordance with procedures outlined on page 14-6.

40 Fill engine oil, transmission oil and coolant systems in accordance with procedures outlined in LO 9-2350-311-12.

Table E-2. Kits/Parts Required to Accomplish Modification.

NSN	Item Name	Part No.	Quantity Required Per: End Item/System Module	Part	Figure and Item No. Fig.	Item
	Modification Kit for Howitzer, M109A3 Engines P/N 12268105 Consisting of:					
	Hose Assembly	MS28759G0330		1	1	1
2940-01-083-5425	Bracket	12260232		1	1	2
4730-00-014-3343	Elbow, Pipe to Tube	11660814-1		1	1	3
4720-01-101-8459	Hose Assembly	11669404		1	1	4
5340-00-809-1494	Clamp, Loop Cushioned	MS21333-105		1	1	5
5305-00-068-0508	Screw, Cap, Hexagon	MS90728-6		1	1	6
5310-00-809-4058	Washer, Flat	MS27183-10		1	1	7
5310-00-582-5965	Washer, Lock	MS35338-44		1	1	8
5310-00-905-0762	Nut, Plain, Hexagon	MS51967-3		1	1	9
5306-00-225-9088	Screw, Cap, Hexagon Head	MS90726-33		1	1	10
5310-00-081-4219	Washer, Flat	MS27183-12		1	1	11
5310-00-407-9566	Washer, Lock	MS35338-45		1	1	12
5310-00-931-8167	Nut, Plain, Hexagon	MS51967-6		1	1	13
4730-00-954-1281	Plug, Pipe, Headless	MS49005-4		1	1	14
4730-00-152-1475	Elbow	10921622-1		1	1	15
5330-00-809-1477	Gasket, Manifold	10919232		2	1	16
5330-00-599-2766	Packing, Preformed	MS29513-222		2	1	17
5330-00-291-7337	Packing, Preformed	MS29513-228		2	1	18
2590-00-806-1146	Seal Assembly	7324411		1	1	19
2990-01-038-8087	Pipe, Turbo Exhaust	12260213		1	2	20
2990-01-043-8192	Insulation, Turbo Exhaust Pipe Front	12260221-1		1	2	21
2990-01-042-2466	Insulation, Turbo Exhaust Pipe Rear	12260221-2		1	2	22
4730-00-908-6264	Clamp, Hose	MS35842-16		11	2	23
5340-01-038-5708	Coupling, V-Band	12260222		1	2	24
2990-01-083-5430	Insulation, Blanket Thermal Exhaust	11636401		1	2	25
5306-00-151-1714	Bolt, Machine	AN5-20		3	2	26
5360-00-809-1454	Spring, Helical Compression	10917102		3	2	27
5310-00-877-5973	Washer, Flat	10910174-2		3	2	28
5310-00-401-0825	Nut, Slotted, Hexagon	MS35692-14		3	2	29
5315-00-234-1854	Pin, Cotter	MS24665-153		3	2	30

(2) Kits, NSN:Unknown, Weight:10 lbs., Dimensions:2X2Xft, Cube:8 cu ft, Security Classification:Unknown.

Figure E-1. Modification Kit, M109A3 Engines P/N 12268105 (1 of 2).

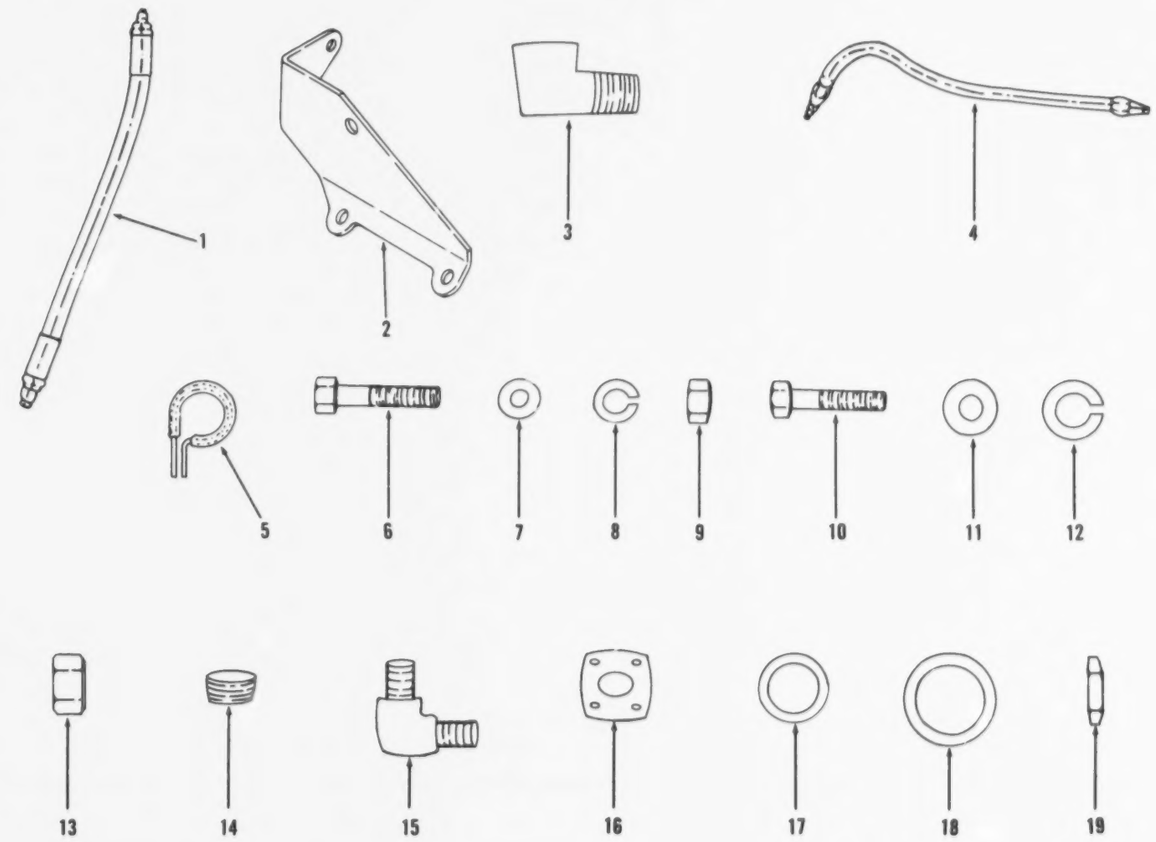


Figure E-1. Modification Kit, M109A3 Engines P/N 12268105 (2 of 2).

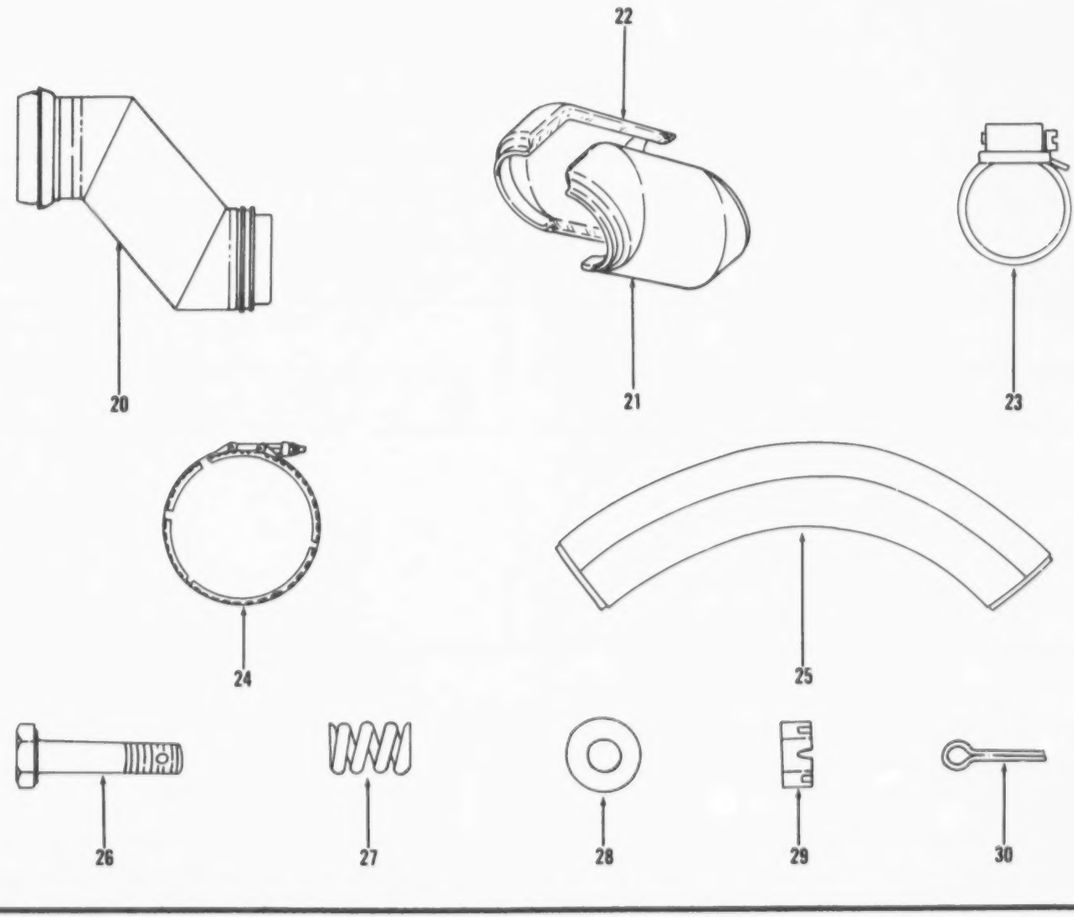


Table E-3. Bulk and Consumable Materials.

NSN	Nomenclature		Quantities
	Hose, Silicone Type II, M62217/1-44	MIL-H-62217	2.75 in I.D. X 2/50 in Long
	Lubricant	MIL-G-10924	?

Table E-4. Special Tools; Jigs; Test, Measurement, and Diagnostic Equipment (TMDE); and Fixtures Required.

Nomenclature	NSN	Part No.	Quantity
Stand, Power Plant	4910-00-084-0790	10913779	1 ea
Sling, Power Plant		10930560	1 ea
Sling, Multiple Leg			1 ea
Wrench, Torque			1 ea

PARTS DISPOSITION

Parts listed below in Table E-5 are no longer required and will be disposed of in accordance with AR755-2.

Table E-5. Parts to be Discarded.

NSN	Nomenclature and Quantity		Part No.
4720-00-010-2756	Hose Assembly	(1)	MS28759-6-0460
5340-00-988-1162	Clamp	(1)	MS21333-113
4730-00-698-4042	Nipple	(1)	AN911-2C
4730-00-088-7363	Adapter	(1)	10885787
	Hose Assembly	(1)	MS18036-5-0164
5340-00-057-3043	Clamp	(1)	MS21333-112
5330-00-809-1477	Gasket	(2)	10919232
2590-00-806-1146	Seal	(1)	7324411
4730-00-994-5787	Hose	(1)	5131575
	Hose	(1)	2.75 in I.D X 2.50 in lg
5330-00-599-2766	Packing, Preformed	(2)	MS29513-222
4720-00-079-6096	Hose	(1)	8711053-2
4730-00-908-3193	Clamp	(1)	MS35842-12
5340-00-472-3038	Bracket	(1)	MS9603-162
5340-00-494-2528	Clamp	(1)	MS9025-24
5305-00-984-6211	Screw	(1)	MS35206-264
5310-00-274-8710	Washer	(1)	MS35338-62
5310-00-934-9760	Nut	(2)	MS35649-202
4720-01-094-9027	Hose	(1)	8711053-1
4730-00-908-3193	Clamp	(1)	MS35842-12
5340-00-472-3038	Bracket	(1)	MS9603-162
5340-00-222-1710	Clamp	(1)	MS9025-22
5305-00-984-6211	Screw	(1)	MS35206-264
5310-00-274-8710	Washer	(1)	MS35338-62
2805-00-079-8666	Support	(2)	10922523
5305-00-688-2111	Screw	(8)	MS90728-63
5310-00-011-5093	Washer	(8)	MS35338-65
5310-00-761-0654	Nut	(8)	MS51967-9
5305-00-071-2067	Screw	(4)	MS90728-111

Table E-5. Parts to be Discarded - Continued.

NSN	Nomenclature and Quantity		Part No.
5310-00-011-6121	Washer	(4)	MS35338-67
2990-00-089-8139	Pipe	(1)	11605415
5330-00-809-5636	Gasket	(1)	10910092
5305-00-576-5417	Screw	(4)	MS35307-360
5310-00-877-5972	Washer	(4)	10910174-3
	Insulation	(1)	11636400
	Insulation	(1)	11636418
	Cover	(1)	11653296-1
	Cover	(1)	11653296-2
4730-00-908-6293	Clamp	(1)	MS35842-15
4730-00-908-6294	Clamp	(1)	MS35842-16
5306-00-151-1714	Screw	(3)	AN5-20
5360-00-089-1454	Spring	(3)	10917102
5310-00-877-5973	Washer	(3)	10910174-2
5310-00-401-0825	Nut	(3)	MS35692-14
5315-00-851-6000	Pin	(3)	MS24665-153
	Pipe	(1)	10931062
5330-00-809-1458	Gasket	(1)	1090993
5305-00-558-5429	Screw	(2)	MS35307-410
5310-00-866-4417	Washer	(2)	10910174-5
2990-00-987-6949	Insulation	(1)	10931089
2990-00-436-2024	Cover	(1)	11604917
2990-00-809-8062	Bracket	(1)	10935745
5305-00-688-2111	Screw	(2)	MS90728-63
2990-00-436-2023	Cover	(1)	11593824
	Insulation	(1)	11636403
4730-00-908-6293	Clamp	(10)	MS35842-15
5330-00-865-2889	Gasket	(1)	10903043
2920-00-247-0011	Clamp	(1)	10917154
5330-00-291-7337	Packing, Preformed	(2)	MS29513-228
4730-00-277-5115	Nipple	(1)	AN816-5-4

Charts Transposed to

End of Volume.

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb.
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

CUBIC MEASURE

1 Cu. Centimeter = 1000 Cu. Millimeters = 0.06 Cu. Inches
1 Cu. Meter = 1,000,000 Cu. Centimeters = 35.31 Cu. Feet

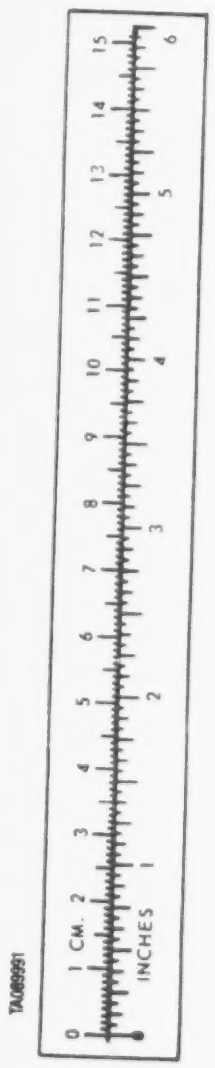
TEMPERATURE

5/9(°F − 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5(°C + 32) = °F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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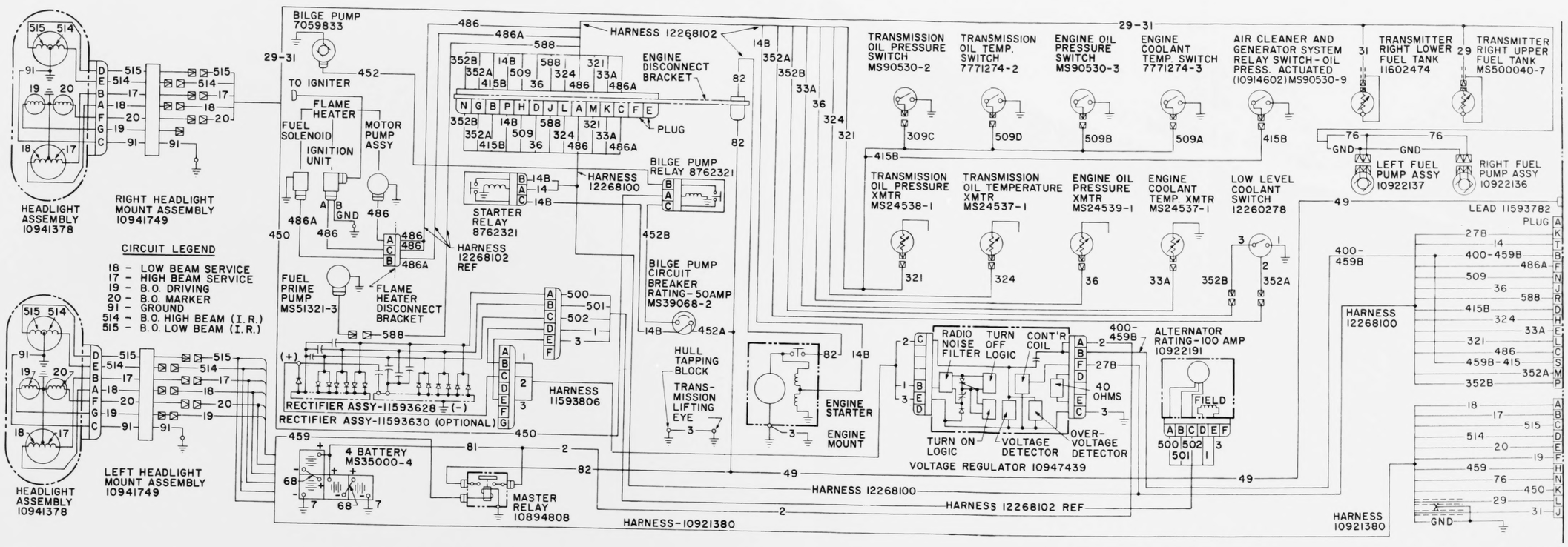

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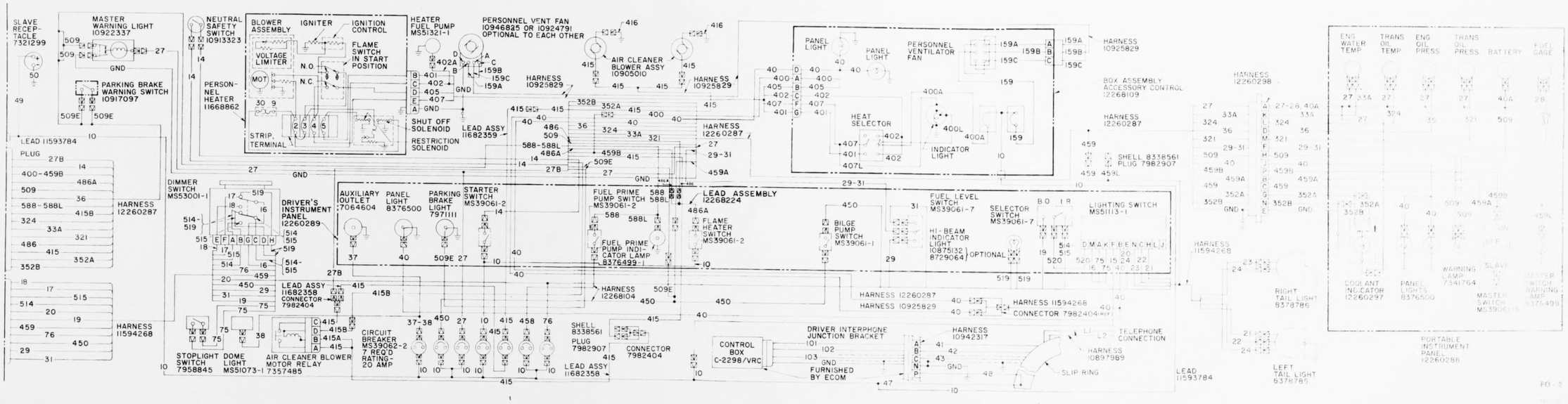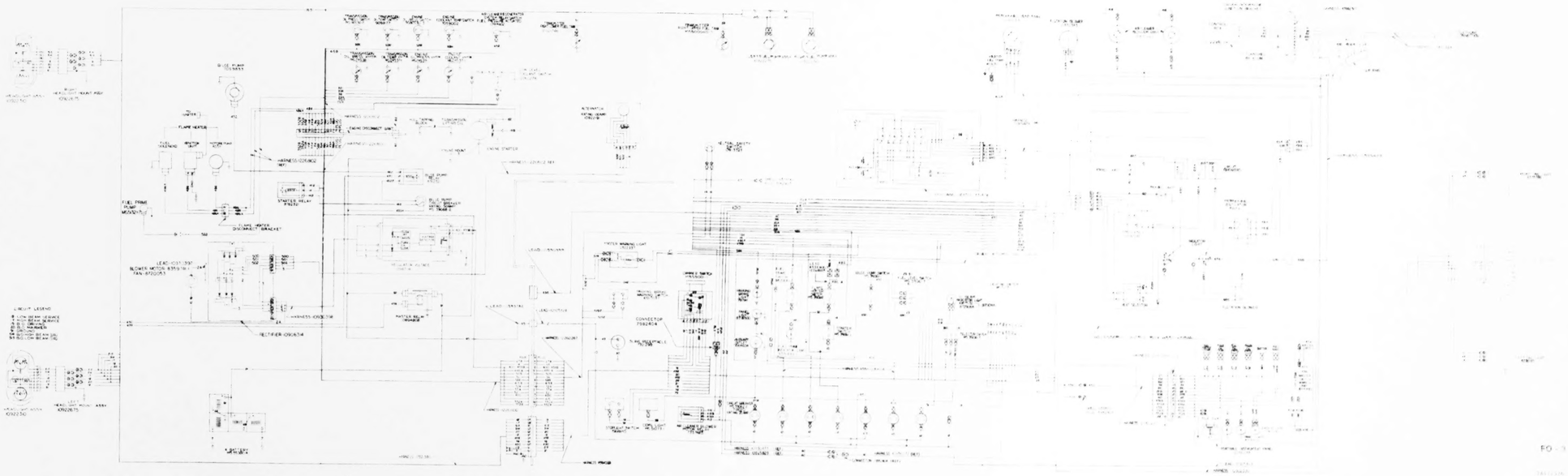
SLAVE RECEPTACLE 7321299
MASTER WARNING LIGHT 10922337
PARKING BRAKE WARNING SWITCH 10917097
NEUTRAL SAFETY SWITCH 10913323
PERSONNEL HEATER 11668862
BLOWER ASSEMBLY
VOLTAGE LIMITER
IGNITER
IGNITION CONTROL
FLAME SWITCH IN START POSITION
STRIP. TERMINAL
HEATER FUEL PUMP MS51321-1
SHUT OFF SOLENOID
RESTRICTION SOLENOID
LEAD ASSY 11682359
HARNESS 10925829
PERSONNEL VENT FAN 10946825 OR 10924791 OPTIONAL TO EACH OTHER
AIR CLEANER BLOWER ASSY 10905010
HARNESS 12260287
PANEL LIGHT
PERSONNEL VENTILATOR FAN
HEAT SELECTOR
INDICATOR LIGHT
BOX ASSEMBLY ACCESSORY CONTROL 12268109
SHELL 8338561
PLUG 7982907
HARNESS 12260298
ENG. WATER TEMP
TRANS OIL TEMP
ENG. OIL PRESS
TRANS OIL PRESS
BATTERY
FUSE GAGE
COOLANT INDICATOR 12260297
PANEL LIGHTS 8376500
WARNING LAMP 7341764
SLAVE SWITCH MS39061-6
MASTER SWITCH WARNING AMP 8376499
PORTABLE INSTRUMENT PANEL 12260288
LEAD 11593784
PLUG
HARNESS 12260287
HARNESS 11594268
DIMMER SWITCH MS53001-1
DRIVER'S INSTRUMENT PANEL 12260289
LEAD ASSY 11682358 CONNECTOR 7982404
AUXILIARY OUTLET 7064604
PANEL LIGHT 8376500
PARKING BRAKE LIGHT 7971111
STARTER SWITCH MS39061-2
FUEL PRIME PUMP SWITCH MS39061-2
FUEL PRIME PUMP INDICATOR LAMP 8376499-1
LEAD ASSEMBLY 12268224
FLAME HEATER SWITCH MS39061-2
BILGE PUMP SWITCH MS39061-1
FUEL LEVEL SWITCH MS39061-7
SELECTOR SWITCH MS39061-7
HI-BEAM INDICATOR LIGHT 10875132 8729064 OPTIONAL
LIGHTING SWITCH MS51113-1
HARNESS 11594268
HARNESS 12260287
HARNESS 10925829
HARNESS 11594268
CONNECTOR 7982404
RIGHT TAIL LIGHT 8378786
LEFT TAIL LIGHT 8378785
STOPLIGHT SWITCH 7958845
DOME LIGHT MS51073-1
AIR CLEANER BLOWER MOTOR RELAY 7357485
CIRCUIT BREAKER MS39062-2 7 REQ'D RATING-20 AMP
SHELL 8338561
PLUG 7982907
CONNECTOR 7982404
LEAD ASSY 11682358
CONTROL BOX C-2298/VRC
DRIVER INTERPHONE JUNCTION BRACKET
FURNISHED BY ECOM
HARNESS 10942317
HARNESS 10897989
SLIP RING
TELEPHONE CONNECTION
GND